DOCUMENT RESUME

ED 317 813	CE 054 637

AUTHOR	Mowery, David C., Ed.; Henderson, Bruce E., Ed.
TITLE	The Challenge of New Technology to Labor-Management Relations. Summary of a Conference (Washington, D.C., October 19-20, 1988).
INSTITUTION	Bureau of Labor-Management Relations and Cooperative Programs (DOL), Washington, DC.; National Academy of Sciences - National Research Council, Washington, DC. Committee on Science, Engineering, and Public Policy.
REPORT NO	DOL-BLMR-135
PUB DATE	89
NOTE	66p.; Product of the Panel on Technology and Employment. For a related document, see ED 286 063.
PUB TYPE	Collected Works - Conference Proceedings (021) -- Information Analyses (070) -- Viewpoints (120)
EDRS PRICE	MF01/PC03 Plus Postage.
DESCRIPTORS	*Continuing Education; *Cooperative Programs; *Emerging Occupations; Human Resources; *Job Development; *Labor Relations; Lifelong Learning; *Occupational Safety and Health; Retraining; *Technological Advancement; Technology

ABSTRACT

This document summarizes a conference organized around four broad topics: (1) skill and employment effects of new technologies; (2) health and safety effects; (3) strategies and tactics for improving labor-management relations; and (4) the role of public and private training and retraining programs. Four conference papers are included as follows: "New Technology and the Organization of Work: A Review of the Issues" (Osterman); "New Technology, Health and Safety, and Labor-Management Relations" (Smith); "Managing New Technology and Labor Relations: An Opportunity for Mutual Influence" (Walton, McKersie); and "New Technology and Continuous Learning" (Zager). Summaries of the discussion of each paper are provided. Appendix A lists the meeting participants. Appendix B lists members of the Panel on Technology and Employment that was organized by the Committee on Science, Engineering, and Public Policy, a joint committee of the National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. (CML)

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The Challenge of New Technology to Labor-Management Relations

U.S. Department of Labor
Bureau of Labor-Management Relations
and Cooperative Programs

BLMR 135
1989

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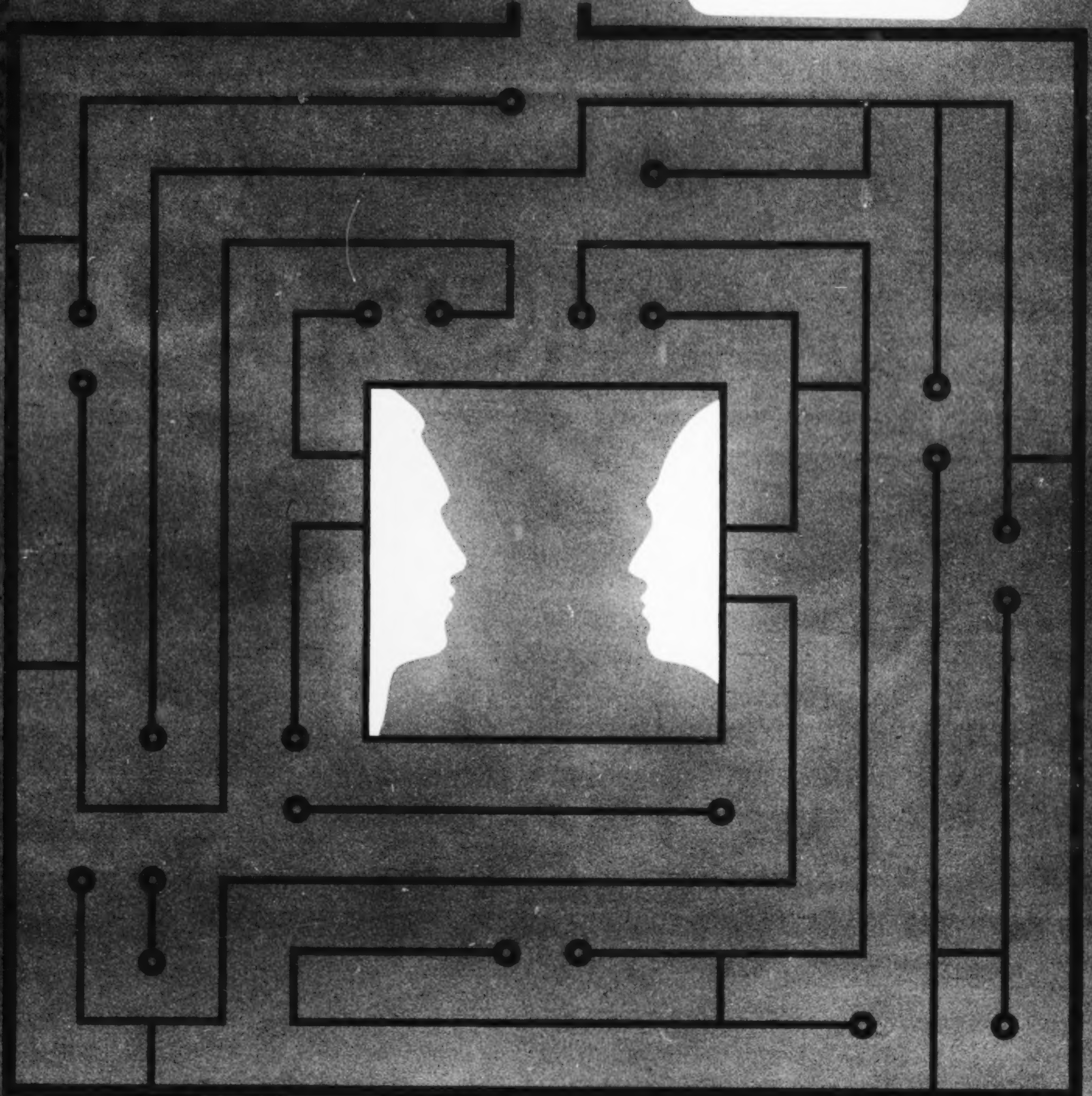

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The Challenge of New Technology to Labor-Management Relations

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U.S. Department of Labor
Elizabeth Dole, Secretary

Bureau of Labor-Management Relations
and Cooperative Programs

BLMR 135
1989

Summary of a Conference Sponsored By:

The Panel on Technology and Employment;

The Committee on Science, Engineering,
and Public Policy of the
National Academy of Sciences,
National Academy of Engineering, and
Institute of Medicine; and the

U.S. Department of Labor,
Bureau of Labor-Management Relations
and Cooperative Programs

Edited by David C. Mowery and Bruce E. Henderson

Contents

Preface i

The Challenge 1

Opening Discussion 3

New Technology and the Organization of Work: A Review of the Issues 5

New Technology, Health and Safety, and Labor-Management Relations 17

Managing New Technology and Labor Relations: An Opportunity for Mutual Influence 33

New Technology and Continuous Learning 47

Conclusion 57

Appendix A: Meeting Participants 59

Appendix B: The Panel on Technology and Employment 61

Preface

In 1985, the Committee on Science, Engineering, and Public Policy of the National Academy of Sciences, National Academy of Engineering, and Institute of Medicine created a Panel on Technology and Employment to examine technology's impacts on employment in the U.S. economy during the next two decades. The Panel, composed of experts from business, labor, government, and academia, released its report, *Technology and Employment: Innovation and Growth in the U.S. Economy,* in 1987.[1] The Panel's report argued that new technologies did not contribute to the problems of low earnings growth and relatively high unemployment that have afflicted the U.S. economy for much of this decade. Instead, new technologies were a vital part of the solution to these problems. An important factor in the recently disappointing international competitiveness of many U.S. firms is the fact that they lagged behind foreign competitors, notably firms in Japan, West Germany, and Sweden, in the adoption of new technologies.

Among the most important influences on the rate and effectiveness with which new technologies are adopted is labor-management relations. The Panel noted that "the potential payoffs from cooperation between labor and management in technology adoption are high, but such cooperation has been lacking in some U.S. industries" (p. 190). Not only the rate of adoption, but the contribution of new technologies in both manufacturing and nonmanufacturing firms to improving the quality of products and worklife and reducing work-related health and safety hazards, can be enhanced by policies that strengthen labor-management cooperation in the adoption process. Although many of the elements of "best practice" in adopting new technologies in a harmonious environment of labor-management relations are well-known, these management practices have been adopted less widely and rapidly within the U.S. economy than many would like.

At the same time that new technologies increase the payoff to a more cooperative relationship between unions and employers, however, they pose serious challenges to labor-management relations. The introduction of new technology may lead to reductions in labor requirements or changes in the skill requirements of jobs, increasing worker concern over job security. Even as they increase the potential for reducing workplace hazards, new technologies and the efforts of many firms to introduce them rapidly may expose workers to substances or processes whose health effects are uncertain or unknown.

New technologies have created powerful challenges to the goodwill and talents of both managers and workers. On Oct. 19–20, 1988, a conference was held in Washington, D.C., to discuss these challenges. The conference was jointly sponsored by the Panel on Technology and Employment and the U.S. Department of Labor's Bureau of Labor-Management Relations and Cooperative Programs. The conference brought together senior representatives of organized labor, management, and academia, along with other experts in the field of labor-management relations, under the joint chairmanship of Dr. Richard M. Cyert, chairman of the Panel on Technology and Employment and President of Carnegie-Mellon University, and John Stepp, Deputy

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[1] A list of the members of the Panel and a summary of its sponsorship are contained in Appendix B of this report. The Panel's report is available from the National Academy Press, 2101 Constitution Ave., N.W., Washington, D.C. 20418. A volume of research papers commissioned by the Panel, *The Impact of Technological Change on Employment and Economic Growth,* was published by Ballinger Publishers in 1988.

Under Secretary of Labor for Labor-Management Relations and Cooperative Programs. The meeting provided an opportunity for a frank exchange of views on a wide range of issues but did not strive to reach consensus or make policy recommendations.

Following a keynote speech by Malcolm Lovell of the Labor and Management Institute of George Washington University, the group discussed four broad topics: (1) the overall skill and employment effects of new technologies, (2) health and safety challenges resulting from the adoption of new technologies, (3) strategies and tactics for improving labor-management relations in the adoption of new technologies, and (4) the role of public and private training and retraining programs. The discussion was guided by a paper and presentation by an expert in each of these four areas: Professor Paul Osterman of the Sloan School of Management at the Massachusetts Institute of Technology, Professor Michael Smith of the University of Wisconsin-Madison, Professor Robert McKersie of the Sloan School and Professor Richard Walton of the Harvard Business School, and Robert Zager of the Work in America Institute.

The report contains the discussion papers, as well as summaries of the remarks of Malcolm Lovell and highlights of the discussion on each topic. On behalf of the Panel on Technology and Employment and the Department of Labor, the editors thank all of those who participated in the meeting, as well as the staff who contributed to its success—Allan Hoffman, Barbara Candland, and Dennis Houlihan of the Committee on Science, Engineering, and Public Policy; and Richard Shore of the Department of Labor. Preparation and editing of the conference proceedings were aided by support from the Center for Research in Management of the Walter A. Haas School of Business, University of California at Berkeley.

The opinions expressed in this report are those of the conference participants and do not represent positions of the Panel on Technology and Employment; the Committee on Science, Engineering, and Public Policy; the National Academy of Sciences; the National Academy of Engineering; the Institute of Medicine; the U.S. Department of Labor; or other sponsors of the Panel's activities.

The Challenge

The challenge facing the conference was described by Malcolm Lovell of the Labor and Management Institute at George Washington University, Washington, D.C. Lovell pointed out that technology plays an important role in determining the organization of work in industry and commerce and influences the structure of labor-management relations. Changes in labor-management relations have often been driven by technological change. Early craft unions in Europe and the United States emerged from a work system that depended on the tools of the craftsmen and the skills of the workers using those tools. The mass production technologies of the late 19th and 20th centuries and the associated deskilling of many industrial tasks gave rise to "vertical" unions organized by industry, rather than by craft. An adversarial system of labor-management relations, based in large part on industry-wide collective bargaining, matured in this environment.

In recent years, dramatic change in production technologies has been associated with two diametrically opposed approaches to labor-management relations. One approach emphasizes the development of a cooperative relationship and strives to increase worker commitment to the firm, for example, through efforts to enhance employment security:

> **We have seen the beginning in some industries of a move away from the prevailing adversarial relationship to a new cooperative mode in which the union commits itself to the economic success of the enterprise, and the management of the business accepts many of the union and worker goals as its own. Most noteworthy is that some managements are now recognizing a tradeoff between employment security and worker commitment to the firm.**

An alternative approach tries to exclude organized labor altogether from the workplace. Lovell argued that growing management opposition to unions and two other factors—the declining share of the work force in traditionally unionized manufacturing industries and some erosion in workers' belief in the value of collective strength during times of economic prosperity—have contributed to a decline in union ranks in the U.S. from 35 percent of the work force in the 1950s to less than 17 percent currently.

Although union power in a number of industries and in the political arena has declined, Lovell argued that few knowledgeable people seriously question the role of unions as an important nongovernmental institution that acts as a counterweight to corporate economic power over working men and women. This is especially true when corporate ownership in many sectors is changing rapidly, often reducing any sense of traditional obligations or beliefs.

Lovell suggested that new technologies support the delegation of greater responsibility to shopfloor workers as advanced communications and information technologies make some components of middle management redundant. Although the deskilling of work is still a management option, it is being challenged by an "upskilling" approach to work organization that is often necessary to produce higher-quality products. The more highly educated, better-trained employees in today's work force respond positively to collegial rather than authoritative management systems. This new environment presents both managers and the leadership of organized labor with significant challenges.

Turning to the public policy arena, Lovell described four broad areas in which structural change in the economy, new technologies, and the changing demographic structure of the U.S. population and work force would require new thinking. Although workers with strong basic skills should not face serious difficulties in obtaining quality jobs, many of the individuals entering the U.S. labor force during the next decade will lack the foundation of basic skills on which employers can develop new job-related skills. The less-educated suffer higher rates of unemployment, are more apt to fall into poverty, and have substantially less social mobility and employment security:

> **As a society we will have to do better in our efforts to make adequate educational achievement a reality for all Americans. It makes no economic sense to spurn technological change and opt for low value-added work to meet the needs of the disadvantaged. It is far, far better to embark on the difficult but more rewarding venture of eliminating the causes of poor educational performance.**

New technologies have both positive and negative implications for workplace health and safety. Although the workplace is a safer environment than it was earlier in this century, Lovell noted the presence of different and potentially serious health effects produced by new technologies. Perhaps of greatest concern are the uncertain, unknown, and often latent risks associated with chemical, biological, and electronic technologies. Unfortunately, few if any of these risks can be prevented by wearing hard hats and safety shoes. Public policies addressing these hazards, including the regulation of workplace safety and health, will require attention in the near future.

Another area in which technological change is affecting the substance of policy debates, Lovell noted, is labor law. If the adversarial relationship between labor and management has indeed become outmoded as a result of technological and other sources of change, U.S. labor laws, drafted on the assumption that this relationship must be confrontational, are overdue for revision:

> **Our labor laws are a product of a former age, an outdated work construct, and a work force holding values and seeking goals different in many ways from those of today. These laws are based on the outmoded assumption that the parties have incompatible objectives and that they are condemned to a never-ending adversarial relationship. Such a relationship is inconsistent with the nation's need for competitive enterprise and its concurrent need for a more committed work force actively sharing in the process of corporate governance.**

A final policy issue that stems from demographic and political factors and interacts with changing technology is national immigration policy. Should the legal immigrant mix be changed to favor more highly educated and skilled people, as is proposed in recently introduced federal legislation? Lovell noted that this issue has traditionally been a matter of conflict between business and labor.

Lovell concluded his assessment by:

> **We have an interesting day in store for us tomorrow. The interplay of new technologies with labor and human resource policies is best contemplated in the totality of developing workplace concerns. I look forward to joining all of you tomorrow as we begin our discussion of these most challenging issues.**

Opening Discussion

At the opening of the day-long discussion, participants were welcomed by cochairmen John Stepp and Richard Cyert. Stepp recalled the 1966 report of the Presidential Commission on Technology, Automation, and Economic Progress. He quoted with approval the report's statement that "technology is not a vessel into which people are to be poured and to which they must be molded," and expressed the view that

> **. . . it is technology that must be molded to mesh with the capabilities, needs, and preferences of workers who must operate the machines of production. What we must strive for in the years ahead is a new means of reconciling the aims and purposes of labor and management in an arrangement whereby they can work together in fashioning new technologies that are as socially constructive as they are economically efficient.**

There is every reason to believe, he asserted, that men and women of good will can design and implement tomorrow's technology in ways that advance the interests and needs of all stakeholders.

Adding his welcome, Richard Cyert pointed out that the U.S. is now part of a global economy. No longer does this nation have (if indeed it ever had) a monopoly on industrial knowledge, knowledge which now moves very rapidly around the world. Productivity growth, which relies on a strong technological foundation, is essential to competitiveness:

> **. . . productivity depends very, very heavily on labor-management relationships. . . . Today . . . we have a real opportunity to pool the experience of a number of leaders in management and labor and from academic life. . . . We can look at approaches that appear to assist in the cooperative adoption of new technologies, and . . . at the issues that impede or support the implementation of these approaches.**

A number of participants acknowledged the importance of establishing mutual trust between workers and management and the need to share the gains resulting from new technologies to maintain the international competitiveness of the American economy. Participants also expressed considerable interest in learning from the experiences of other companies and other unions. Discussing the importance of more rapid productivity growth and technology's role in achieving it, Thomas Donahue (Secretary-Treasurer, AFL–CIO) noted that

> **. . . we need to see the prospect of gain sharing in the application of that technology and in the enhancement of that productivity. Wrapped into all of those problems for us, I think, is the question of cooperation. . . . Certainly none of the trade unionists at this table would dispute the validity of that cooperation, but [we are concerned] about cooperating in ways in which we do not lose our identity or lose our effective bargaining power because, until the millennium and until we all have the same concepts of gain sharing, workers are going to need an effective force to represent them. . . .**

Presenting the perspective of a large employer in a high-technology industry, Larry McKean (Vice President, Corporate Labor Relations, Boeing Company) noted that, during the past year, his firm had introduced 2,000 new chemicals into the workplace.

A number of these were associated with the large-scale use of nonmetallic composite materials, while others were responses to federal airworthiness and product safety directives. Boeing workers had expressed growing concern about apparently adverse reactions to some of these chemicals. McKean noted the importance for Boeing of worker safety and expressed a strong desire to learn from others in dealing with the health and safety implications of rapid technological change.

John Jordan (Senior Vice President, Corporate Development and Human Resources, Bethlehem Steel Corporation) emphasized the importance of the role and philosophy of the chief executive officer in establishing the tone for corporate labor relations: ". . . it makes all the difference in the world in a corporation in terms of how you get things done. . . ." Responding to a number of comments about the development of knowledge among workers and managers of "best practice" methods for managing the adoption of new technologies, Robert Zager noted that many of these practices are not new, but have been around for nearly a century—a fundamental issue, which received attention throughout the course of the day and raised questions as to why they have not been adopted more widely.

New Technology and the Organization of Work: A Review of the Issues

A Paper Prepared by
Paul Osterman

Sloan School of Management
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Everyone knows that new technologies will reshape work. Everyone also knows that this reconfiguration will have deep impacts upon the distribution of workers across occupations and firms and upon the skills which employees will be expected to bring to work. The rub comes when we move beyond these easy generalizations. What will be the "job description" of the white collar or production worker in the 1990s? Will their work become more or less skilled, broader or narrower? How will the organizational transformations induced by information technology feed back upon careers?

This paper will attempt to answer these questions, but we will not pretend that there is any single identifiable impact which flows automatically from the nature of the technology and which the discerning researcher can extract and identify. Instead our view is that the impact is contingent upon decisions made by individuals and institutions. In some circumstances, technology will lead to one set of outcomes while in other settings the same technology will have quite different effects. We will also argue that efforts to implement new technologies in a manner which combines high productivity with broad skilled jobs and an acceptable degree of employment security will require innovation in labor-management relations.

Our perspective stands in contrast to the more traditional argument. In this view—which has long dominated both scholarly and popular thinking—there is a single optimum way to configure a given technology. Much of the employment system surrounding the technology is therefore simply derivative of that technology. The only real challenge is to discover that optimum arrangement and move toward it as quickly as possible. Also implicit in this view is that the technology in some sense drives its users toward the optimum, and so over time if we observe firms employing the same technology, we will also observe very similar employment systems and productivity.

What evidence is there of the variable impact of technology? Numerous observers have noted that similar or identical technologies are used in dramatically different ways in different settings. For example:

- In recent studies of automobile production, researchers have been able to hold the level of technology constant and examine several measures of productivity. High technology strategies in the absence of human resource innovations do not achieve productivity gains. However, even modest investments in technology when combined with flexible labor practices lead to significant productivity improvements (Krafcik, 1988).

- Another striking example is provided by a study of the implementation of flexible manufacturing systems conducted by Jaikumar (1986). He compared similar FMS systems in firms in the United States and in Japan. In Japan, the time it took to develop the system

> was half that of the United States, the number of different parts the Japanese set-ups produced was much higher, the labor requirements lower, the fraction of the day the machines ran was higher, and total output was higher. Jaikumar attributed these differences to the skill level of the labor force and the amount of training provided by firms, i.e., to human resource policy.

These, of course, are just examples, and we need more evidence before the point is established (and additional material provided throughout the paper). It is also important to remember that the point can be exaggerated: The nature of a technology does set limits or establish patterns. For example, Piore and Sabel (1984) distinguish between flexible and mass production technologies and argue that the possibilities of each are quite different with respect to a range of issues, including shop-floor relations and macro-economic policy. This point is similar to the long-standing discussion in the sociology literature concerning the relationship between technology and organizational form (Thompson, 1967; Woodward, 1965). Nonetheless, it is apparent that one cannot understand outcomes by reference to technology alone; additional considerations must be brought to bear.

Because of this variation, the most useful role for a paper like this is to identify the range of the possible outcomes and attempt to explain what factors determine which path the impact will follow. In the first half of the paper, we examine the descriptive evidence and try to summarize the facts regarding how new information technologies alter job design. In the second half, we consider what lies behind the considerable variation in outcomes. We close with some questions which policy makers might consider.

The Traditional Debate About Job Design

Do new technologies lead to more narrow and deskilled work or to broader more complex jobs? Which course is the most desirable from the (differing) perspectives of the several interested parties? These two questions, the first empirical and the second normative, have dominated debate on this topic.

Followers of Frederick Taylor believe that there is a single best way to accomplish any task. This "best way" can be discovered by management experts and then conveyed to the labor force. The key assumption is that the labor force has nothing to contribute to the production process. In effect, employees are simply appendages to machines, and therefore the most cost-effective approach is to drive skill out of work and operate with as low-cost a labor force as possible. This motivation may be supplemented by a desire to limit employee knowledge of the production process and hence concentrate power in management hands.

Although few people would identify themselves with as crude a view as the foregoing, it seems hard to deny that these attitudes underlie much of the American production system. In *both* union and non-union settings, narrow job categories, strict work rules, lack of sharing of information concerning new technology, and the general absence of involvement of workers in planning production all flow from a Tayloristic approach to organizing work.

Implicit in this line of thought is the assumption that new technologies, by replacing human skill and judgment, deskill the labor force. Such deskilling is seen as technically efficient and as a nearly inevitable consequence of the technology. A good illustration of the kind of innovation which (seemingly) fits this logic is the advent of electronic switching in the telephone industry. Prior to the introduction of electronic digital switching, the repair of mechanical switching equipment was a highly skilled craft job in which an individual developed a substantial "feel" for the equipment. Wires would break, circuits would fail, foreign matter would get into the equipment, and the craftsperson's job was to find and fix the fault. By contrast, the new system is essentially a computer. The rate of mechanical failure is low, and repairs are more straightforward in that modular boards can be removed and inserted. Software failures are more likely to be the province of programmers than craftpeople. All of this is not to argue that the new repair jobs are not skilled. However, the nature of the skill has changed considerably, and it is arguably the case that from the former craft perspective the job has been deskilled.

It is possible to argue that the move to electronic switching and the shift in job boundaries which ensued were due to the characteristics of the technology itself, in that the substitution of computers, or "boxes" as they are derisively termed by telephone people, inevitably implied a loss of skill on the part of the craftsmen. For this reason, the introduction of electronic switching can stand as an illustration of the "technological imperative" perspective (although even this proposition is open to some question, since it begs the issue of whether the old craftsmen were taught the new programming skills).

Whereas the Tayloristic perspective held sway for many years, recently the burden of opinion has swung against it. Two points are notable about the shift. First, much of the impetus has come from observations of how work is organized in other countries, not just Japan but also European nations such as Germany and Sweden. In each of these nations, high quality, efficiency, and cost advantages seem to accrue from empowering, not deskilling, the labor force. Second, these lessons seem to hold across a range of technology, from relatively simple to highly sophisticated.

Perhaps the most persuasive evidence comes from that most Tayloristic of industries, automobile production. The Japanese organize their production systems in a way which permits extensive worker interaction with technology and this seems to have large payoffs. A striking way of capturing this notion is the phrase "giving wisdom to the machine," which Shimada and MacDuffie (1986) use to describe the interaction of Japanese production workers and technology. They define the concept as follows:

> **This refers to innovative activities carried out through the joint efforts of production workers, engineers, and supervisors in the attempt to improve the capability of machines and production systems by modifying or adding relevant functions to them. . . . A second component is self-management of the work process, which contributes substantially to the self-generating innovative property of the system. . . . While production standards and the basic framework of work methods are given by engineering requirements, production workers have the discretion and responsibility for specifying work content . . . and [they] revise them continuously, based on their daily production experience.**

There are similar examples from other industries. For example, in a study of circuit board design, Salzman (1985) examined whether computer-assisted design (CAD) technology deskilled circuit board designers. His conclusion was that it did not. While it was possible to use a relatively unskilled employee and a CAD system to design a board, the outcome was not satisfactory. There was enough non-programmable intuition and "feel" required that the prevailing view was that such a board "would look like a board designed by a computer." Far better results flowed from using the new technology but making it a tool in the hands of skilled workers.

Evidence along these lines is accumulating. This evidence contributes to a more general phenomenon, the reconsideration of work organization induced by more volatile and competitive markets and by evidence that less rigid forms of work organization are more productive. Therefore, what is special about the current period is that the organization of work is being reconsidered, and the impact of new technologies can best be understood in the context of this broader reconsideration. Firms, unions, and outside observers are asking whether a continued adherence to the Tayloristic strategy makes sense or whether alternative models should be considered and adopted. What gives it even greater urgency is that we are in the midst of a wave of new computer-driven technologies. We now ask how the character of these innovations alters the terms of the traditional discussion.

How Information Technology Changes the Terms of the Debate

Why has the discussion about technology taken on new urgency? After all, technological innovation is hardly a new phenomenon in the American economy. What lies behind current concerns is the perception that information, or computer-based technologies, represents a departure.

There are three distinctive aspects of the technology which shape its impact upon the organization of work. These are:

- Tighter integration across functions and tighter inter-dependencies of activities;
- More rapid speed and real-time response;
- More costly consequences of errors and breakdowns.

Beginning with the first point, computers and information technology link previously semi-independent aspects of the production system more closely. This is true for both blue and white collar work.

Paul Adler (1986) provides a persuasive example of this phenomenon from banking. Vastly oversimplifying Adler's description, one can speak of a transition between two states. Prior to the introduction of computers, the processing of customer requests and accounts by the "front office" resulted in a paper flow to the "back office" which was entered into account records. Each of these clusters of activities involved numerous steps, but there were various checks on errors. Because of the paper flow, an error made by a teller could be caught by a back office processor. Under the new regime, computers integrated the two functions to the point that tellers introduce data directly into the bank's account data base. This led to great efficiencies but also to considerable risk. The point here is that a series of separate functions were tightly linked together.

A good manufacturing analogy is flexible manufacturing systems (FMS). These automated systems typically consist of a series of machine tools for cutting combined with materials moving, production planning, and inventory control systems. All of these are under the control of common computer systems, and these systems also include extensive monitoring and simulation capacities. What in the past had been a series of separate work stations are now linked, and the activities of one are tightly interwoven with the activities of the next. However, the integration extends beyond the simple notion of physically linking work sites; much tighter links evolve between different functions such as planning, control, and operations. These different functions now share a common real-time data base (Graham and Rosenthal, 1986).

The second distinctive characteristic of new technologies is speed, and it should be clear from the foregoing examples that the speed of system performance increases as functions are linked together by computer. In one sense, the production system becomes much more powerful than before. However, it is also important to realize that the consequences of errors increase sharply. To borrow the language of Shimada and MacDuffie (1987), the production systems become less "robust" and more "fragile."

In a robust production system, an error or delay in one part of the system does not reverberate with serious consequences elsewhere. For example, if there are quality problems with several cars they are taken off line for repair, and normal production continues. Similarly, the system is protected from external shocks because a large inventory of parts is maintained on the premises. By contrast, in a fragile system, quality is maintained on line as part of the normal flow of production (each station is responsible for repairs), and inventory is kept to a minimum through just-in-time systems.

In a number of ways, the fragile system is quicker and more efficient. It saves in time because of its high attention to quality at all points, and it saves in money because it need not maintain separate repair staff or high inventories. However, the system is much more vulnerable to problems. The system has low tolerances for failure, and each step in the system is dependent on the successful operation of each other step. Errors are propagated by virtue of the higher interdependence of the production system. The adverse consequences of a problem are magnified.

Shimada and MacDuffie develop the distinction between fragile and robust production systems in the context of their discussion of automobile production, but the concepts apply just as well in other settings. For example, Adler's example of a bank, described above, demonstrates how the introduction of information technology led to a more fragile production system in a nonmanufacturing environment.

Organizational and Human Resource Implications

The technical characteristics described above—tighter integration across functions, more rapid response time, and increased fragility of the system or costliness of errors—carry with them implications for the organization of work within firms.

Even casual reflection on the technical aspects of the technology identified above raises questions about the Tayloristic strategy. In addition to the more general case for a high-skill labor force—"giving knowledge to the machine"—the characteristics of information technology add additional reasons for high skill. In an environment in which activities are tightly linked and in which the costs of errors are high, it does not pay to risk a labor force which does not understand the system and cannot respond to problems.

An example which links together these points is provided in a report on the implementation of a materials requirements planning (MRP) system in a large aircraft manufacturer. (Schneider, Howard, and Emspak, 1985). This computer-based system predicts parts needed in a manufacturing process and schedules their arrival. It replaced a manual system operated by white collar employees. Although the MRP system had the potential to achieve great efficiencies, it could only accomplish this if the system operators maintained their old skills while building up new ones. This was because of the importance of exception processing, in which "the role of the worker is to handle those frequent situations where the computer system, however technically sophisticated, is too crudely programmed to respond to the complexities of the real world" (p. 51). In addition, because the system centralized what have previously been dispersed responsibilities, failures or problems had much wider ramifications than in the past. This increased the knowledge requirements of the operators and also implied that they exercise more judgment as to when to override the system, lest important parts not go to where they were most needed at the moment.

This rationale for increased skill levels does imply, however, that the nature of skill will shift. The emphasis will move away from manual skills and toward working with data and understanding the operation of the entire system. Indeed, this aspect of information technology is at the heart of Zuboff's (1988) distinction between automate and infomate. Zuboff argues that information technology will distance workers from the physical "feel" of production and will require, instead, that they learn the meaning of the data generated by computer-driven processes and discover how to fit these data together into a coherent understanding of the process. A very similar argument was previously advanced by Hirschhorn (1984).

In order for firms to take advantage of the possibilities of the technology, they must be willing to teach employees enough for them to gain this overall vision and then permit the labor force to act upon it. This requires both a new version of skill, from the labor force's perspective, and a considerably more trusting and teaching-oriented management than has traditionally characterized American firms. As is apparent, then, this message is very similar to the lessons derived from studies of American and Japanese auto production as well as from other cases.

An important element of new skills required by information technologies will be responsibility. In most instances, the system may perform well on its own but the importance of spotting and understanding malfunctions increases sharply. Some researchers argue that there is a dangerous irony associated with this issue. Although the responsibility is great and the costs of failure very serious, many monitoring jobs are boring for most of the time. The consequence is that when problems do occur workers may be in some psychological sense unprepared (Hirschhorn, 1984).

Information technology will reshape work well beyond its impact on specific jobs. The way jobs link together will change, and new forms of work organization and career patterns will emerge. Several examples illustrate this point. On the production floor, considerable evidence suggests that work teams, in which job boundaries are quite diffuse, are more productive than more traditional arrangements (Katz, Kochan, and Keefe, 1987). A useful example along these lines, and one which harks back to our earlier discussion, is provided by MacDuffie and Maccoby (1986). They describe AT&T's move from mechanical to electronic switching and report on an initial effort by the company to limit programming knowledge and diagnostic skills to staff at central offices. In the field, under this plan, the role of the technician was simply to carry out repair orders. This led to considerable organizational conflict, as experienced field workers sought to maintain their power, and was inefficient in that problems could be identified and repaired more rapidly via cooperation. The benefits from teams were established by the emergence of an informal, and underground, effort by the field workers to gain the knowledge and tools which the company sought to limit to central staff. Productivity was higher when the underground worked.

The most significant development along these lines is the tendency of information technologies to break down organizational barriers. Within the firm, separate functions such as design and manufacturing will be integrated more closely. Across the firm, the boundary between customers and their suppliers will become blurred, as the firms work jointly on designing products and have access to each other's databases for the purposes of ordering parts and updating inventory.

The dissipation of these traditional barriers has several implications.

1. The traditional roles of supervisor and manager change. We have already hinted at this point. Because employees have more access to data, they will take over many of the functions associated with supervisors. For example, production planning, inventory control, and quality control will increasingly be under the control of employees. This will pose a major threat to lower-level supervisors.

Just as employee roles will change, so will the skills required to be an effective manager and supervisor. As Zuboff (1988) has emphasized, teaching skills will become increasingly important. Managers will need to be willing to share their knowledge of the production process and technology with workers and, assuming they are willing, they will need to learn the skills necessary to do so.

2. The stress induced by the role shifts outlined above may be exacerbated by another impact of information technology. Based on a series of interviews with managers, Attewell (1985) concludes that the greater availability of data has two contradictory impacts on managers' perceptions about their jobs. On the one hand, they feel greater *local* control because they have more information on what is occurring in their area of responsibility. On the other hand, they feel greater *global vulnerability*. Because the information technology links together disparate areas of the organization, a given manager is more immediately impacted by actions elsewhere. This is a consequence of the shift discussed above toward a fragile system. Managers feel a loss of control over events that affect their performance.

3. The breaking down of intra- and interorganizational boundaries may also have significant implications for careers, although these implications are not yet well understood. As teams become a more important organizational form, individuals will need to learn new roles and skills, and promotion patterns may shift (Ancona and Caldwell, 1987). For example, whereas in the past many firms have emphasized technical abilities, in the future, skills involving negotiation, persuasion, and conflict management will become salient. Furthermore, difficult issues will arise regarding career tracks and compensation, as the logic of production increases the rate at which individuals move between different units (for example, there is a trend for engineers to "follow the product" from development labs to manufacturing facilities), and this alters traditional career paths (Westney and Sakakibara,1988).

Understanding the Variation in Technology's Impact

We have argued that there is a debate, at the level of practice, not simply theory, about how to organize work. We have also argued that new technologies shift the weight of considerations in the direction of broader, higher-skilled jobs. Nonetheless, it is crucially important to remember that the debate is far from resolved. Comparable technologies have different impacts in different settings. One firm may use factory automation not simply to improve quality and reduce labor input per unit but also to sharply reduce actual employment levels. Another firm will use the same technology to maintain employment. In one setting, operators receive training and learn how to use the data and control possibilities of technology to manage the production process; in another firm, control and planning is shifted to managers, and the labor force is deskilled. How can we explain and understand these variations?

Our goal is to develop a framework for explaining the empirical variation which we observe. Even casual reflection suggests that such a framework needs to be able to encompass a range of factors. Clearly, purely economic considerations should play a role: Firms for whom cost cutting is a major competitive priority will deploy technology differently from firms which can sell all they can produce at assured prices. However, this cannot be the entire story since there is also evidence that firms in the same industry behave differently. There must be a role for firm-specific philosophy and human resource systems. Finally, the pattern of cross-national variation suggests that national characteristics, for example, differences in training and education systems, must play some role.

The Product Cycle. There is substantial evidence that human resource practices vary in a systematic way with the firm's position in the product cycle (Flynn, 1988). Growing firms, or divisions of firms responsible for products which are growing, place great emphasis on product innovation and recruiting adequate numbers of employees with the appropriate skills. Cost minimization is not the most salient goal.

Because the competitive advantage of a firm early in its product cycle is the innovative quality of the product itself, there is a high premium on maintaining this advantage by continuing to innovate. As a consequence, new technology is conceived as a way to augment the product. Technology most effectively enhances products when combined with a skilled labor force.

The skill-enhancing impact of information technology which characterizes its use by firms early in the product cycle contrasts with how the same technology can be employed by firms producing mature products. In these circumstances, the major competitive edge firms seek is cost, not product innovation. As a result the emphasis shifts to using new technology to reduce employment per unit of output. It is in these settings where we observe the most negative employment consequences of information technology.

The labor-cutting strategy is likely to be intensified when a substantial portion of labor costs is accounted for by pools of relatively homogeneous employees. A firm with a very large level of clerical employment (a bank or insurance firm) or large numbers of semi-skilled operatives will be especially eager to reduce employment and will feel that there are few constraints in terms of the skill or knowledge lost when employees leave.

One reasonable question is why firms cannot have it both ways. Why can they not simultaneously employ information technology to shed labor and produce more efficiently while also upskilling their remaining labor force and innovating in the product market? Such a strategy is not impossible. It is relatively straightforward when the employment effect is not outright job loss, but rather slower employment growth and a falling dose of labor input per product. However, the story is different when actual job loss occurs. The difficulty is that the strains induced by labor shedding may block the level of work-force cooperation required to innovate successfully. Employees will ask themselves why they should creatively engage with the technology when the consequence may simply be that they or a workmate lose their job.

Finally, it may be important to distinguish between the product cycle and the technology cycle. In the foregoing discussion, we emphasized the income and price elasticity of product demand, i.e., the product cycle. Flynn (1988) has also developed evidence that the impact of technology varies over the lifetime of the technology itself. Early in the introduction process, she argues, "uncertainty in the quantity and quality of skill requirements, coupled with unavailability of workers already trained in the newly emerging fields, encourages employers to add new tasks onto existing jobs—at least on a temporary basis" (Flynn, p. 39). Hence upskilling is the likely outcome. Over time, as the technology itself becomes better understood it becomes possible to routinize, and sub-divide, employment, and this in turn implies deskilling. In short, Flynn argues that there is a technology life cycle as well as a product life cycle effect.

The Firm's Human Resource Strategy

American firms are pulled in two directions regarding how to organize work. Some firms, in both the union and the non-union sector, are adopting systems of job classification, wages, and employment continuity which are flexible and involve high levels of job security. In these systems employees agree, either explicitly or implicitly, to take on a wide range of activities and to provide a high level of effort. Narrow work rules and job classifications are abandoned or not pursued, and pay may become more contingent upon individual or group performance. In return for this flexibility, the firm undertakes to make a substantial effort to maintain employment even in the face of temporary downturns. An important aspect of this may be the extensive use of temporary and other forms of contingent labor, to whom implicit or explicit employment commitments are not made.

Other firms find this model too expensive or too much at variance with their philosophy of management. The competing model is to try to improve productivity through strong, and often unilateral, management actions. Rather than employment continuity, hire/fire is the rule. The natural consequences of such an approach are strong efforts by the labor force to protect themselves via clear and well-defined work rules, job boundaries, and the like.

The former approach to organizing work has been termed the "salaried model," and the latter the "industrial model," (Osterman, 1988) and it is far from clear which will emerge as the dominant way of organizing work in America. It is clear, however, that they have very different implications for understanding how technology impacts upon the organization of work.

In order to understand the relationship between these alternative human resource strategies and technology, recall our earlier evidence on the disparate impacts of technology. The best current evidence is that effective use of information technologies implies that employees exhibit considerable flexibility on the job and that knowledge and understanding of the production process be widely diffused. It is impossible, however, to achieve such a system in isolation from the rest of the firm's employment practices. The employment relationship has to be viewed as a whole: Compensation, employment security, and training systems must be internally consistent and aimed in a common direction. What this logic implies, of course, is that firms which seek to deploy new technologies in the empowerment sense will likely adopt salaried models of human resource management. Or, switching the causal arrows, firms with a tradition of "progressive" or salaried models of work organization will be the ones in which technology is most likely to be deployed in an upskilling and job-enhancing way.

Because technologies appear to have higher payoffs when in the empowerment mode and because this implies a broader reform of human resource practices, many firms are seeking to find ways to organize at least a core of their labor force along the lines of the salaried model. Many of the innovations in human resource management—work teams, quality of work life, and increased use of contingent workers (temporary and part timers) to shield the employment security of the core labor force—can be understood as efforts to shift to the flexibility of the salaried model.

Although many firms are attempting to capture these gains, many others either do not believe that the benefits are worth the costs or that they are in a position to undertake the necessary investments in human resources. There is, for this reason, considerable variety in firms' human resource strategies. Hence the central point here is not that the labor market is shifting in one particular direction. Rather, to return to our effort to understand the variable impact of technology upon employment, the point to emphasize is that one significant variable is the nature of the firm's internal labor market and human resource system.

Finally, it is important to note that strong collective bargaining relationships can make a considerable difference. When unions and employers are able to discuss technology, job design, and work rules the result can be more effective use of technology and broader, higher-skilled jobs. There are notable examples of such a result in the auto and telephone industries among others. Not all collective bargaining relationships can achieve this, however, and the difficulties often lie on both sides of the table. Nonetheless, the nature of the collective bargaining relationship is an important variable in explaining the impact of technology.

The External Environment

Understanding the impact of the product cycle and human resource strategy takes us much of the way in explaining the diverse impacts of technology upon employment levels and skills. However, this cannot be the complete story for the apparently systematic variation across countries in the use and impact of technology. Nations such as Germany, Sweden, and Japan seem to achieve higher productivity than does the United States for comparable technologies.

In part, the explanation can be cast in terms of our two prior considerations. For example, Japanese firms, or at least the large ones at the core of the economy, provide lifetime employment and are organized with considerable internal flexibility and high levels of training. Hence, these are in some sense salaried firms and should be expected to reap the benefits of that model. A similar point could be made regarding many European nations who also provide more job security to their labor force than do we (and the similarity of the European and Japanese models belies arguments which attribute high European unemployment to inflexible labor markets).

Although part of the observed international variation can be explained by reference to other factors, deeper reflection does suggest that there are systematic factors *external* to the firm which vary across nations and which help explain why there are systematic national patterns. The three which seem most relevant for our purposes are training systems, employment continuity, and traditions of labor-management-government cooperation.

Most of our competitors provide far more training, particularly to blue collar workers, than we do (Osterman, 1988). The vehicle for this training varies—in Germany and Sweden an extensive apprenticeship system is combined with high school education, while in Japan training occurs within the firm's internal labor market—but in all cases, the volume of training is higher than ours. The consequence is that firms have a highly trained labor force able, and indeed eager, to adapt to new techniques. For example, some German automobile firms have introduced new techniques specifically to take advantage of the technical skill of their labor force.

The second salient characteristic of the external environment is that other nations provide more job security or employment continuity than we do. Again, how this is done varies. For example, in Japan firms follow a lifetime employment model, while in Sweden layoffs are nearly as common as here (after excluding temporary layoffs which are more widely used in the U.S.), but an extensive employment and training system combined with narrow wage differentials and the welfare state cushions the cost of job loss. However, in both cases, and in other nations as well, workers are willing to provide considerable latitude on job flexibility because the risks of doing so are diminished. Hence, the impact of new technologies is very much in the upskilling direction.

Finally, many other nations have a strong tradition of union-management-government cooperation around innovation and industrial policy (Walton, 1987). Those with the strongest such traditions seem to do best in adopting new techniques and in deploying them in ways that enhance the quality of work.

Conclusion

Rather than review the arguments in this paper, it seems most appropriate to conclude by listing some of the major unresolved questions which emerge from the analysis. The purpose of this is to both help guide discussion and to indicate that much remains to be understood.

1. We have seen that the evidence suggests that modern technologies are most productive when implemented in the context of flexible human resource systems, which provide the labor force with a high level of involvement and employment security. The evidence for this is, however, based on a limited number of case studies that may not be representative. Furthermore, implementation studies of "best practices" often focus on success cases or on practices which accord with the prior beliefs of researchers. Hence, these studies are not necessarily representative of the range of practices and possible outcomes in the economy as a whole (i.e., there may be a set of cases which are "worst practice" from the researcher's viewpoint, which therefore are rarely studied or reported, but which produce desirable outcomes). We must ask ourselves, therefore, how ultimately strong is the argument and whether the evidence is good enough to convince people who might believe that tougher and less appealing approaches will in the end succeed.

2. If we do find the foregoing argument convincing, how can best practices be diffused? One approach is to build an education and training infrastructure which, at least indirectly, helps encourage the highest skill uses of technology. A second strategy is to strengthen collective bargaining relationships which have the potential for encouraging best practices. A third step is to directly deploy public policy to demonstrate, underwrite, and diffuse the models which seem most promising.

Following these three tacks may seem sensible, but it will be difficult. In part, the difficulties will be political, but there are also deeper problems. We also must admit that we lack a good model or strategy for encouraging private actors to undertake a particular course. Considerable thought needs to be devoted to how to proceed.

3. We have written as if there was an average effect of technology which applies equally to all impacted workers. This is an oversimplification, and even if the optimistic case were to emerge, not all employees would share equally. There will be some inevitable job loss and dislocation associated with the diffusion of new technology.

In addition to job loss, we must also recognize that efforts by firms to move to a "salaried" model often imply use of contingent workers to buffer a permanent labor force. The substantial growth of these contingent workers is in part reflected in the burgeoning growth of temporary employment firms (who supply high-skilled workers as well as clericals). However, and perhaps more interestingly, recent union contracts (for example the National Steel contract, the Master Teamsters contract, and several auto agreements) permit employers to hire a fraction of the labor force under contingent or insecure contracts.

It is not clear who is reponsible for training these employees or for providing any reasonable level of employment security. These considerations suggest an additional role for public policy: training, job search assistance, relocation assistance and other activities aimed at avoiding the emergence of a two-tier labor market.

As these three questions suggest, there is much more to learn about the impact of new technologies and their implications for both the organization of work and the best direction for public policy. There is, however, plenty of reason to believe that if we go to the trouble to think through these issues, learn more, and implement sensible policies then the payoff will be high to society, employees, and firms.

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Discussion

The discussion following Professor Osterman's summary of his paper was opened by Joseph Mahon (Assistant Postmaster General, U.S. Postal Service), who commented on Osterman's argument that technology melds job titles and classifications, creating new ones. Mahon noted that the introduction of technology is a complex undertaking in a workplace with a single industrial union, but that

> **. . . it becomes infinitely more difficult to address when the employees of a company are represented by different unions. . . . That is a problem that we in the Postal Service are facing. . . . We have four major unions representing substantial segments of our 750,000 employees.**

In response, Thomas Donahue discussed consolidation among unions. In 1955, there were approximately 148 unions in the U.S.; today there are 91, a number that includes several recent mergers. Although the membership and basis for the autonomy of some unions may have been affected by changes in the structure of individual industries or sectors, Donahue noted that union members have to be persuaded that it is in their interest to merge. In several instances, including unions in the pulp and paper industry and the proposed merger of the Oil Chemical and Atomic Workers Union with the United Mine Workers, union leadership has been unable to convince the membership of the merits of a merger.

Donahue expressed agreement with Osterman's emphasis on the tradition of union-management-government cooperation in other nations and its comparative absence or weakness in the United States. Referring to recent political controversies over the minimum wage, advance notice of plant closings, and other issues, he argued that

> **. . . all these things have become religious struggles by now. We have been through them for 50 years. . . . And yet we go on doing them because . . . the institutions on the employer side . . . don't seem to show the flexibility that the constituents of those institutions preach in these kinds of contexts and these kinds of meetings.**
>
> **We need this flexibility in cooperation not just in the adaptation of a work force in a plant to new technology, but we need it in the adaptation of the institutions of workers and employers in the public policy issues. . . . We have seen nothing happening there and in the major corporations in this country who are interested in the more narrow subject need to make their voices felt in the larger subjects in their own institutions. . . . [This] would vastly change the attitudes in the nation and . . . [strengthen] the kind of institutional cooperation of labor, management, and government which other nations have demonstrated is essential to their success.**

Lynn Williams (President, United Steelworkers of America) and Malcolm Lovell agreed with Donahue's statement. Lovell suggested that one factor contributing to business opposition to policies such as advance notice of plant closings, which many firms carry out voluntarily or as a matter of contractual obligations, is the need of Washington-based business lobbyists to demonstrate their capacity to win policy battles. In order to demonstrate their effectiveness, Lovell suggested, these lobbyists often press firms to adopt uncompromising positions on issues where both labor and management could benefit from a less polemical debate.

Donahue argued that one factor contributing to the strength of business opposition to advance notice and to the broader adversarial tone of policy debates was the ability of smaller firms, which often are not unionized, to gain the attention of Capitol Hill. In some instances, he suggested, the specific policy goals of these firms are not shared by organizations that represent larger firms. Nevertheless, larger firms often lend support less out of conviction than reflex.

The group considered the role of employment security policies in the adoption of new technologies. Morton Bahr (President, Communications Workers of America, and a member of the Panel on Technology and Employment) described one of the practical difficulties that his union and management at the AT&T company had encountered in implementing a policy of employment security. Although this policy guarantees priority consideration for job openings within AT&T, these jobs often require relocation. The Communications Workers have found that the rise of the two-wage earner family has significantly reduced the mobility of some workers, hampering the operation of the employment security program. For example, only 6 percent of a group of 1,200 AT&T technicians took new jobs within AT&T that required relocation. Similarly, only 15 out of 800 employees at a plant in Winston-Salem, North Carolina, that was being closed accepted jobs at an AT&T plant in the Merrimack Valley of Massachusetts. Worker reluctance to relocate creates serious problems for the operation of employment security programs, Bahr suggested, and results in a significant gap in no-layoff policies at many firms.

Tony Picardi (Group Personnel Manager, Digital Equipment Corporation) responded to Bahr's remarks by describing the practices of his firm, which has long had a no-layoff policy:

> **[At Digital] . . . no layoff really means no layoff. . . . We ran into some of the same things you discussed . . . with dual-career families, people not wanting to move. . . . When people elected not to move, they were kept employed in that plant. We did retraining where we could, and in some cases people were sitting in plants with nothing to do, but . . . no one left at the company's discretion.**

Paul Osterman noted that the policies of Digital and other firms may increase employment security for one group of workers while another segment of the work force is employed on a "contingent" basis, as in the case of temporary office employees or contract personnel in a manufacturing plant. Referring to a study by his colleagues of Digital's employment security policy, Paul Osterman described the Digital program as a model for corporate employment security, retraining, and relocation efforts. Osterman noted, however, that Digital has as many as 3,000 temporary or contract employees to whom the no-layoff policy does not apply.

Osterman's comment stirred considerable discussion. Lynn Williams noted that the use by steel firms of contract, nonunion employees within their plants had become

> **. . . a core issue in our last negotiations in terms of . . . insisting that the jobs in the mill be jobs for our members and for the workers who built these enterprises in the first place. And we are very disturbed in our union about this whole notion that there should be some ever smaller core and that we say, 'Okay, we congratulate ourselves, we have accomplished employment security,' while in truth we are running the operations with all kinds of outsourcing and all kinds of contractors moving in and out. . . .**

John Read (Vice President, Mid-Range Engines, Cummins Engine Company) questioned how Williams could reconcile his opposition to the use of contract workers with the cyclical nature of the steel industry and the need for corporations to respond to such cyclical fluctuations. Williams responded that his union supported management's efforts to manage cyclical fluctuations,

> **but we think when they are in the up cycle that workers who have a connection with the industry are entitled to have those kinds of good jobs. . . . If we had not taken a stand on that issue we would have seen our plants taken over by outside contractors of one kind or another.**

Morton Bahr noted that his union has not opposed the use of temporary or contract workers for temporary or project work, but does oppose the assignment of these personnel to permanent jobs. Read responded that Cummins Engine, which faces significant cyclical and seasonal fluctuations in demand, has long utilized temporary employees. He added that the firm has had to exercise care to avoid excessive use of such employees because of the problems that extensive use creates for worker morale and cooperation.

William W. Scranton, III (President, Smith and Hawken, a mail order supplier of garden tools, and a member of the Panel on Technology and Employment) noted that genuine job security within the U.S. economy of the future requires more than advances in collective bargaining. The only assurance of better jobs for the workers of the future lies in strengthening the capacity of the nation's work force and business leaders to adapt to change. To do so, he asserted, will require that the skills of the work force be continually upgraded, as the U.S. continues to move toward a knowledge-based, rather than a materials-based, economy. Yet there exists no consensus on who is going to do the upgrading and training. Academia does some of it. Government does much of it, including primary and secondary education. Corporations do a large share of it. Corporations and unions share a common and substantial interest in this issue. But without some consensus on the division of responsibility among these institutions and an agreement that improvements in the capabilities of the work force are essential to the welfare of all Americans and deserve additional resources, too little will be done.

Morton Bahr concluded the opening discussion by describing the origins of recent joint management-labor training initiatives within the telecommunications industry. A "Common Interest Forum" was established by AT&T and its unions in 1983 for discussions of mutual concerns. Through the Forum, Bahr explained, sensitive corporate information was shared with union leadership for the first time, and the process reinforced trust between management and union leadership.

Despite a 26-day strike in 1986, Bahr argued that three significant developments came out of the Forum discussions. The Alliance for Employee Growth and Development, a non-profit corporation dedicated to an employee development and training program that built on the experience of programs developed by the United Auto Workers and auto firms, was established in the 1986 negotiations. The Alliance, which is co-sponsored by AT&T and the CWA, allows employees to pursue career-oriented training that need not be related to their specific jobs; they can even prepare themselves for a career with another employer. The Forum discussions also resulted in AT&T granting "card-check" recognition of the union in unorganized workplaces and produced an agreement for the company and union to work together to design a new "greenfield" work site, a process that will involve collaboration in the design, introduction, and implementation of new technology. Emphasizing the importance of trust and continuing discussions between management and labor that span the interval between contract negotiations, Bahr emphasized that

> **. . . this could not have come about if the Common Interest Forum had not been negotiated and . . . trust [established] at the highest level where these things were discussed months and months before collective bargaining began.**

New Technology, Health and Safety, and Labor-Management Relations

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The American dream: to achieve success and happiness, to be safe and secure, to own a home, to have good educational opportunities for our children, to have the freedom to express ourselves. These and many other freedoms, opportunities, and challenges are the cornerstones of our democracy and our way of life. All are influenced by the commerce and business activities of our country. Our jobs help to define who we are, what we can afford, and where we live. Working is at the heart of the American dream. Our beliefs about the right to have a job, and our commitment to the men and women who labor to make this dream a reality, are of vital importance to what America stands for and to its economic survival. One right that epitomizes our commitment to the American dream is the right for employees to have a safe and healthful place of work as defined by the Occupational Safety and Health Act of 1970. The drafters of this legislation had the foresight to be concerned not only with the physical and chemical hazards of that time period, but also the psychological dangers of work and the new and emerging hazards of the future. Today, workplace hazards that were unknown in the 1970's are a reality of serious dimensions and challenge our ingenuity. Tomorrow's hazards may be even more disconcerting. The old ways of dealing with occupational safety and health need to be reviewed and very likely revised to meet the challenges of the future.

The world of work is changing at an amazing pace. New technology is transforming the workplace and bringing with it hazards that were unknown a few decades ago (OTA,1985). New chemicals, plasma gases, biotechnology, computers, electronics, robots, miniaturization, and genetic engineering pose new threats, and challenge our knowledge about hazards as well as our ingenuity in controlling them. These challenges will tax the capabilities of our current health and safety resources, and may not be amenable to traditional safety and health approaches. A major difficulty is that we just do not have enough knowledge about these hazards or their potential, harmful effects to be able to make perfect choices for solutions. Even more frightening, needed knowledge about health hazards will be even scarcer for future technologies. This is because they do not have similar counterparts today to give us experience to use in determining their hazard potential or for developing controls. This lack of knowledge puts us in a precarious situation. We want to use these technologies to provide competitive benefits in international economic markets, improved profits and a better society; yet we do not want to use them at the cost of harming workers. Our challenge then is to use them in productive and healthful ways, and this may require rethinking how we approach occupational safety and health.

Opportunities and Challenges

New technologies provide unique opportunities to improve the workplace. It goes without question that the steady pace of technological improvements in factories since the industrial revolution has produced a cleaner, brighter, more efficient, and safer environment for factory workers. In particular, the physical drudgery of heavy physical work has declined, while the constant direct exposure to dust, fumes, and chemicals has been reduced. This steady improvement will continue with more new technology that will further reduce physical demands. New technology also has the potential to replace current technology that is dangerous and thereby reduce hazard potential. New machines that reduce a worker's exposure to moving machine parts, new chemicals that can be substituted for harmful ones, and new processes that eliminate the need for using dangerous levels of radiation are examples of current developments in new technology that will be safer. New technology also provides the opportunity to restructure the organization of work and the design of jobs so that physical and mental stress can be reduced or eliminated.

But, new technology also presents several challenges. There is research that indicates that some forms of today's new technologies have created working conditions that are less favorable than in the past (Smith, 1985, 1987). Offices that appear to be "paper factories," hospitals where workers put in two consecutive 8-hour shifts because they have the needed technical knowledge, and factories that look like offices, but where many workers are so underutilized that they suffer from depression and fear of job loss, are some examples. It has often been said that new technology is benign; that it is the application that produces problems. In other words, the misapplication of technology to enhance organizational performance at the workers' expense is the problem. Dealing with the misapplication may be the greatest challenge of new technology. Still, there are others. New hazards will emerge for which we have no knowledge and experience. Our ingenuity and ability to respond rapidly will be challenged. Lastly, the opportunity to develop new approaches to occupational health and safety will pose challenges to our organizational structures, public policy institutions, professional organizations, unions, managers, and workers. The need to change from a reactive response system to a proactive and "ever-vigilant" system will demand institutional change and individual energy and initiative that many may be unwilling to give. The challenges are many, but so too are the opportunities.

Current Institutions and Resources

There are many actors in the occupational health and safety theater: doctors, nurses, industrial hygienists, safety engineers, educators, trainers, managers, workers, union officials, researchers, federal agencies, state agencies, local agencies, courts at all levels, law makers in various jurisdictions, safety and health inspectors, administrators, and many others. These can be arranged into organizational groupings of legislative, legal, regulatory, union/worker, company, and community resources. It is not often that many of these groups work together to deal with policy issues or even with the specific concerns of a particular public health and safety problem. One recent exception is the AIDS health crisis, but this is an unusual situation. New technologies do not have the immediate public response or psychological impact of AIDS, but many of these technologies may have greater potential to kill or injure people than AIDS. The lack of a comprehensive national public policy to address the health and safety issues of new technology almost precludes coordinated action among the various constituencies; yet this coordination is necessary to provide the constant attention that new technology demands. No single group or organization has enough resources to meet these demands, but together they do.

We must start with a comprehensive federal policy from the Executive Branch that specifies actions for directing resources toward activities that will promote the most effective use of new technology in improving the economy and promoting health and safety. Currently, there are several agencies such as Commerce, Defense, Labor, Internal Revenue, Education, Agriculture, and Health and Human Services that deal independently on specific issues of new technology without considering the impact of their actions on the activities of the other agencies. To address this, nongovernmental and government institutions such as the National Academy of Sciences, National Academy of Engineering, and the National Science Foundation have formed study groups of "experts" that develop reports to provide guidance and direction to the Executive Branch and Congress. Sometimes, these reports have some impact, but usually not to the extent necessary to produce the desired action(s). The President has a science advisor who could serve as a critical link between the scientific community and the Executive Branch in developing policies on new technology. This person could serve the coordinating role needed in the Executive Branch to tie the programs of various agencies together into a concerted effort. Unfortunately, science advisors sometimes get involved in political issues such as strategic arms initiatives and lose credibility among the groups to be coordinated. The Executive Branch needs to use the science advisor as a coordinator to lead efforts to develop a comprehensive, integrated national policy. It should start with the establishment of a federal task force on new technology with the science advisor as the chairperson and all federal agencies involved in new technology represented. This group should report findings along with recommendations for action to the President within a short time of being established.

The U.S. Congress has a head start on the Executive Branch because of the establishment of the Office of Technology Assessment (OTA). This agency has developed several studies and reports for Congress that assess economic, social, and health and safety issues of specific new technologies. These reports are used by the Congress as the basis for hearings which may lead to legislative action. While OTA is an excellent mechanism in concept, there are some problems in practice. Most technological issues that are studied are proposed for study by specific individuals or groups in Congress. The choice of issues thus may be motivated by political concerns instead of a desire to benefit the workforce. Because of the political nature of the subjects selected for study, legislative action, other than hearings, is rare. To counter this, it would be reasonable for the OTA staff to generate some of the issues to be studied. This may not be politically palatable, but would increase the perceived validity of the topics examined by OTA. Secondly, Congress should look into establishing a new technology impact panel that would coordinate action and funding across federal agencies dealing with this topic. This panel could interface with the President's technology task force. This would force interaction and joint efforts which may produce a more balanced treatment of the benefits and liabilities of new technologies.

Within some federal agencies, special functions that assess the health and safety impact of new technologies are absent and need to be established. For instance, the Defense Department is a major funder of new technological developments and places primary emphasis on the performance of the technology rather than on the health and safety impact. A balanced emphasis needs to also consider health and safety. Within the Department of Labor there should be more coordination between bureaus that have interest in new technological impact. For instance, those programs that are concerned with employment, worker training, unemployment, workers' compensation, and safety/health should have a mechanism to be made aware of the other bureaus' actions. This may serve to coordinate actions and to generate ideas for new research. In particular in Labor, the Occupational Safety and Health Administration (OSHA) should have a special group that keeps abreast of new technologies and develops regulatory and other means to resolve emerging safety and health problems. This group should provide advice and direction on research needs to other agencies such as the National Institute for Occupational Safety and Health, the National Institute for Environmental Health Science, the National Institutes of Health, the Food and Drug Administration, and the Department of Agriculture.

Finally, our current labor/management system of collective bargaining is just too slow to keep up with the ever-changing world of technology. Some efforts at joint action have been successful in limited situations as will be shown later. But, these have been too few and of limited scope. They will not be adequate to address the many issues of new technolgy. A major flaw is that they have not been based on complete trust; rather they have endured in a "show me" climate. Even when the results of a particular consideration have been positive, new situations start from the premise of mistrust until proven otherwise. The adversarial relationships of current collective bargaining approaches will not be effective in dealing with the hazards of new technology because these hazards require a constant willingness to make changes quickly. A new cooperative dimension needs to be added to collective bargaining that is specifically aimed at new technology.

Measuring Success

Today there is debate about the number of persons that die or get injured or sick each year from occupational injuries and diseases. Different groups that keep statistics on these deaths, injuries, and illnesses, such as the Bureau of Labor Statistics, the National Center for Health Statistics, and the National Safety Council, each come up with different totals every year. This creates arguments about statistical sampling error, underreporting, differences in reporting criteria (what counts as a case), and methodologies used to collect data. The National Academy of Sciences, National Institute for Occupational Safety and Health, and Bureau of Labor Statistics have all recently examined occupational injury and illness reporting systems in depth and have made recommendations for improving the current systems. These recommendations will produce improvements that will make these systems better indicators of the general state of occupational safety and health including long-term consequences of new technology. These recommendations need to be implemented as soon as possible.

However, even with improvements, current systems are much too slow to be responsive to the "potential" injuries and illnesses of new technologies. Processes and materials are changing so fast that the demands on these systems have greatly increased. Many of these new technologies will have a life cycle that is too short for changes to be statistically observable while the technology is in use. New surveillance systems have to be developed that are closer to the action in the workplace and the new technology. These surveillance systems should supplement the current systems (once the current systems have been improved). One such system for monitoring hazards and health symptoms, the hazard survey, will be discussed later. This or similar systems need to be available in select representative workplaces that are undergoing technological change so that problems can be researched in detail and discovered as they occur, rather than months or years later. This case study technique for defining potential problems poses some questions about methodology, concerns about representativeness, and burden on select employers that need to be examined carefully. On the other hand, it provides immediate access to critical information that may help to head off problems before they become serious health or safety hazards. It provides a yardstick of where we are and where we want to go. The Bureau of Labor Statistics should institute a program of conducting these case study evaluations as new technology is implemented, and widely disseminating the results as they become available. Detailed documentation of case findings can provide the supplementary details missing in national statistics.

Technology and Emerging Occupational Safety and Health Problems

Traditional hazards such as unexpected energy release and new chemicals will still be with us in the future workplace. The use of lasers, robots, microwaves and x-rays will become more common, and with their use the traditional problems of controlling energy release and limiting worker access to hazardous machine components will still be around. However, these will be even more problematic than today because of the more complex nature of the mechanisms of energy release, and because of the enormity of the forces involved. For instance, the energy to generate x-rays for lithographic etching of computer chips is several times greater than used in conventional diagnostic x-rays. The safety precautions for this type of instrumentation must be much better than current standards for diagnostic use.

In addition to these, other new hazards will emerge. Some will be the exotic products of genetic engineering and biotechnology, while others will be the products of our ability to harness the laws of physics and chemistry with advanced engineering designs. The future will see commercial uses of plasma gas generators for tool hardening, electron accelerators for generating tremendous power for x-ray lithography in micro-chip production, and fusion power generation. These will become everyday tools used by thousands of workers and many will not be well educated or knowledgeable of the tremendous power of the technology they will be working with.

While these physical and biological hazards will become more prevalent and dangerous than they are today, there will also be more physical and psychological work demands that can lead to psychological stress problems. Currently, the two fastest rising workers' compensation claims areas in the United States are cumulative musculoskeletal trauma and psychological distress. The rise in these problems can generally be related to two factors. There is greater media, worker, and employer awareness and knowledge about how the workplace can contribute to such problems, and secondly the huge increases in workplace automation that create conditions that produce these disorders. It is possible that dealing with these stress-induced problems may be even more difficult than dealing with the biological, chemical, and physical hazards. A current example may demonstrate the variety of concerns posed by new technology which integrates old and new hazards.

In the last decade, millions of video display terminals (VDT) used to display the output of computers have been deployed in hundreds of offices. This has produced a ground-swell of complaints from workers about the visual and musculoskeletal demands imposed by working at a VDT (Knave & Wideback, 1987; Smith, 1987). After a decade of debate and research, there is a growing consensus that poor workstation design coupled with increased workload and postural demands can contribute to shoulder, neck, back, and wrist/hand disorders for many users. In 1988, the American National Standards Institute (ANSI) established an ergonomics standard for VDT use in the workplace to control these hazards. This standard was five years in the making and appeared some ten years after the potential hazards were first defined.

Of equal interest is the claim that working at a VDT poses a radiation hazard, is correlated with reproductive disorders and creates user stress. Today, there is not sufficient research evidence or experience with similar technology to allow us to answer these questions with any degree of certainty. The debate most likely will continue for some years to come. We can learn from this example. Manufacturers and employers initially reacted to worker complaints about VDTs with skepticism. Little was done to try to confirm the nature and extent of the problems. Why? Office work is clean. There are no hazards! Thus, the complaints must be from malcontents and troublemakers. Unions reacted with scathing attacks on the motives and intentions of industry. Government agencies were impotent in responding to this issue because there were no standards or guidelines that applied. An ANSI standard for VDT work was adopted only in 1988, and still there are several health and safety questions about VDTs unanswered and unresolved by this standard. The message is clear. Even if VDTs are found not to be hazardous, the responses of the business community, unions, government, and universities to the VDT health debate illustrate an unproductive way of dealing with new technology and its potential hazards. Divisiveness, finger pointing, denial, and arguments do not solve problems, they create new ones.

New technology can mean different angles on old hazards (x-ray use in computer chip manufacturing), and new hazards for which we have no experience to help us in defining their nature and seriousness. New technology changes how work is done, and can affect the worker's psychosocial balance which can lead to stress. As a nation, we have not been successful in dealing with these concerns through our traditional institutions such as government and collective bargaining. Yet other nations and some individual companies have had some success in approaching these issues.

Approaches to Occupational Health and Safety

Traditional approaches to occupational health and safety in the United States have stressed the enforcement of rules, regulations, and standards, often coupled with worker training. The responsibility for safety and health has resided with government agencies and the management of specific corporations. Various corporations meet this responsibility through a wide variety of safety and health programs, and by distributing the responsibility to various management levels based on corporate philosophy and policies. Some businesses are large enough to have safety and health departments that serve as resources to line departments and as dispensers of services; many are not. Whatever the size of the business, typically, the point of safety action is the interaction between the first-line supervisor and the employee. This interaction is controlled by rules and policies, and by the personalities, experiences, and commitments of the supervisor and the employees. At this level of interaction, there is a high degree of technical knowledge about workplace safety hazards, but very little knowledge about health hazards, and practically no knowledge about technological hazards.

In the past, such an approach has been most effective in dealing with fixed physical hazards that have obvious characteristics that make them distinguishable, and for which engineering controls are well documented (Smith et al, 1971). For instance, standards for machine guarding have had considerable success in reducing the number of upper extremity amputations. However, a major problem with this approach is that it is reactive; it responds to hazards only after a clear danger has been established and a method for control has been identified. This approach requires a body of research or empirical evidence that clearly defines the problem, and which can support recommendations for control. This often takes several years when addressing new products, processes, and technologies. With the rapid changes in technology, such delays in dealing with potential hazards cannot be accepted. Hazard control for new technology requires a new process that will be dynamic enough to be able to deal with the increasing rate of technological change.

An example will illustrate the problems with a traditional approach. Success in controlling new chemical hazards has not been completely effective using the traditional standards-setting approach. It typically takes several years to recognize the potential hazards of a specific chemical. It then takes more years for definition of the chemical's specific effects, and determination of controls. For many chemicals, for instance benzene, this entire process can take several years and end in litigation before the Supreme Court. In the meantime, many workers continue to be exposed to potentially serious hazards. A second problem with this approach is that the diseases caused by most chemicals take years to develop, and almost as much time passes before symptoms are recognized as serious health problems. New advances in behavioral toxicology attempt to develop early warning symptoms and reductions in physiological/behavioral response to identify hazardous chemical exposures before biological damage occurs (Johnson and Anger, 1983). In some cases the behavioral tests used for early identification of adverse exposure have been successful, while in others more developmental research is necessary. To date, this approach is still in its infancy and will require several more years of development.

Another concern is that laboratory research on animals can take several months or even years for results. Technology is changing much too fast to wait years before results are complete. Each year, at least 1,000 new chemicals are introduced into the workplace that are not tested for toxic effects because there is a shortage of testing facilities, research animals, and other resources. New scientific methods to screen chemicals for potential toxicity which use insects and bacteria for test subjects have some potential for helping. But, they need even more refinement than the behavioral toxicological tests. Technology may help us to perfect these approaches, but that will take some years.

When we move from industrial chemicals to consider the potential hazards of biotechnology, these new testing methods may no longer be viable. The biotechnological process may directly interfere with the mechanisms of toxicity evaluation (for instance, bacterial testing of a chemical), rendering their results doubtful. In addition, the potential hazards of biotechnology are much more complex than those of industrial chemicals. These may represent new forms of life for which we have no previous biological or toxicological experience. Will new strains of bacteria for improving cheese production have unexpected side effects on humans? Aside from biotechnology's new hazards, other new technological processes, such as building computer chips with x-ray lithography, create unique challenges for controlling old hazards. In essence, the nature and complexity of the occupational health and safety situation is changing because of the complexity of technology, and the old ways of dealing with hazards will not suffice.

Health and safety, like most industrial relations functions, has traditionally been addressed through the enforcement of federal laws and within the collective bargaining agreement. This makes the structure for labor/management relations an adversarial one. When the employer is not in compliance with the regulations, the union brings the situation to management's attention. If action is slow, then the union calls in OSHA to attain compliance through the regulatory process. This generates ill will and, often, denial of the problem. For problems that are not black and white, for instance the VDT debate or repetitive motions that may cause carpal tunnel syndrome, the process of hazard amelioration can take years because of arguments about causation and legal actions. In the meantime, workers may be exposed to serious hazards without the benefit of methods of amelioration. This scenario is all too real in the American workplace. Adversarial actions produce polarized responses, finger pointing, and denial, which yield little action in getting to the heart of the potential problems. This approach cannot address the challenges of new technologies. However, there are several other approaches that may have some potential for addressing the emerging hazards of new technology.

Successful Safety Programs

Research on successful safety program performance in plants with high hazard potential has shown a number of factors which contribute to success (Cohen, 1977; Smith et al, 1978). These are having a formal, structured program so people know where to go for help, having management commitment and involvement in the program, good communications between supervisors and workers, and having worker involvement in the safety and health activities. Experts feel these factors are effective because they provide a framework for cooperation between labor and management in identifying and controlling hazards. These factors parallel the basic underlying principles of the social democracy, hazard survey, and ergonomic committee approaches (discussed later)—that is, cooperation, participation, and honest exchange of ideas about problems in a controlled format. These can be the building blocks of future efforts to deal with the potential hazards of new technology.

One focal study summarizes the importance of total involvement and cooperation. Cleveland, Cohen, Smith, and Cohen (1979) studied five National Safety Council members who were award winners for having the most successful safety programs in their industry classification for several years. Three were chemical plants, one a textile plant, and the fifth was a photoflash manufacturing facility. Each was sent a comprehensive questionnaire survey that addressed aspects of their safety program. Later each was visited for a comprehensive on-site evaluation using a checklist of safety program characteristics. Of special interest were the findings that safety committee activities were more important in hazard control than having professional safety staff. In addition, having a committed workforce that participated in safety on a daily basis was a key element in their success. That workforce should be trained, particularly the first-line supervisors together with the line workers. Finally, having regular procedures for keeping up to date on the nature and extent of hazards was an important program characteristic. This research identifies the importance of all levels of plant personnel being actively involved in hazard identification and control, and carrying these responsibilities out cooperatively.

The Need for New Safety and Health Approaches

Based on our understanding of successful approaches to safety and health and the unique nature of the emerging hazards from new technologies, a central feature of any new safety and health approach(es) to new technological hazards must focus on changing the confrontational relationship between the workforce (labor unions) and management. Just as high quality and productivity can best be achieved through cooperation and trust (see Lawler, 1986), so too can the control of emerging technological hazards. The "them" against "us" mentality will not be successful. It imposes too many delays for effectively controlling these rapidly changing hazards. New approaches have to be "proactive" rather than reacting to crisis after crisis. This demands that labor and management work together to keep on top of the developments in the application of new technology. That is not to say that labor and management cannot "confront" each other on specific issues. Such confrontation is an essential ingredient of collective bargaining. Rather, I am suggesting that such confrontation be undertaken from a different perspective than is currently the case. It should be done in an "informational" way. That is, if labor reports a problem that is ignored by management, then the safety process should "force" each side to gather information and talk through what is gathered immediately, and in a spirit of discovery rather than debate. When this does not work, then there is ample time for confrontation through the normal collective bargaining grievance process.

Scandinavian Social Democracy and Safety and Health

One framework for addressing the health and safety issues of new technology is the social democratic approach practiced in Norway and Sweden (Emery & Thorsrud, 1969; Gardell, 1977). This approach is based on the concept that workers have a right to participate in decisions about their working conditions and how their jobs are done. In Sweden, there are two central federal laws that establish the background for health and safety. One is similar to our Occupational Safety and Health Act and established agencies to develop and enforce standards as well as to conduct research. The second is the Law of Codetermination that legislates the right of worker representatives to participate in decision making on all aspects of work. This law is effective because over 90 percent of the Swedish blue and white collar workforce belong to a labor union, and the unions take the lead in representing the interests of the employees in matters pertaining to working conditions, including health and safety. A major difference between health and safety regulation in the United States and Sweden is that in Sweden the health and safety process is customized at the local plant level so that issues of specific interest to a particular plant can be emphasized. The laws allow for some flexibility in addressing local concerns. This is in contrast to the OSHA concept which requires all plants in the United States to meet identical standards of compliance using the same or equivalent procedures. While the Swedish approach does have specific standards for exposures and safety guarding, it allows for individual plant initiative in achieving the control of the hazards.

The Scandanavian approach also puts more emphasis on the quality of working life in achieving worker health and well-being. Thus, there is emphasis on ensuring that job design and technology implementation do not produce physical and psychological stress. A example would be the Swedish approach to the VDT debate. Concerns about VDT safety originated in Sweden in the early 1970's when field research indicated that VDT users had visual complaints. Based on employee concerns, unions and management at specific companies developed programs for eye care, improved workstation design, better VDT design, and improved job design. The Swedish Telecommunications Administration is a prime example of this cooperation to solve VDT problems. As specific concerns, for example visual problems, have arisen they have been ready to solve the problem, in this case, by designing a better VDT screen and by instituting a comprehensive vision health program for all employees. When musculoskeletal problems came along they designed and manufactured a new electrically adjustable workstation to provide better postural conditions. As the debate on reproductive effects continues, they allow transfer of employees on request away from VDT work and participate in government-sponsored research to determine the nature and extent of the problems (Ostberg, 1986). This is not to say that similar efforts are not to be found in the United States. Several U.S. employers have also taken the same or similar measures that Swedish TeleCom took and also are currently participating in U.S. government VDT research. The difference is that in Sweden the action was taken when the problems were first reported, while in the U.S. it has taken years for employer response. In Sweden the response is widespread, while in the United States it is the exception.

When it comes to less well-defined VDT health issues such as job stress, there has been a much greater difference in the Swedish and U.S. employer response. In Sweden, federal safety laws prohibit overly repetitive, "boring" work as detrimental to employee psychological health. Companies and unions work together to develop jobs that have broadened content through various measures such as job enlargement and enrichment, job rotation, and employee participation. There are no federal laws in the U. S. that would mandate similar requirements even though research has demonstrated that many VDT jobs are highly repetitive and stressful (Smith, 1987). The Swedish approach to social democracy may not be acceptable or even desirable in the United States because it requires a legislative mandate for worker (union)/employer cooperation. It specifies participation in decisions about the design of work and the application of technology as a worker right through the participation of the union in company policy and decision making. This is vastly different from the collective bargaining approach typified in the U.S. In addition, a much smaller percentage of the U.S. workforce is unionized (about 22 percent versus 90 percent), and problems of implementation in nonunion companies could occur. Specific aspects of social democracy, such as cooperation between labor and management, employee involvement in job design, and recognizing that work is more than a paycheck, may be useful in developing a model of labor relations for health and safety considerations in using new technology.

Employee Involvement

Organizational and job design experts have long proposed that employee involvement in work enhances motivation and produces efficiency and product quality benefits (Lawler, 1986). Examples of this are the Scanlon Plans used in the U.S. during WWII, quality circles pioneered in Japan, quality of working life committees and joint labor/management committees for solving production problems and ensuring product quality. Some health and safety experts feel that employees should be involved in safety programming and hazard recognition to promote safety motivation (Peterson, 1979). An effective example of using this concept in health and safety is the Hazard Survey Program (Smith, 1973; Smith, 1985). This program was started at the University of Wisconsin in the early 1970's as an alternative to formalized safety inspections of plant facilities. The central concept is that employees know more about their jobs and the hazards of their jobs than anyone else. Research at the University and the Wisconsin Department of Industry and Labor (Smith et al., 1971) showed that most hazards were either transient or due to improper organizational or individual behavior. Such hazards are not likely to be observed during monthly formal inspections by safety staff or annual compliance inspections by state or federal inspectors. The theory proposes that the way to keep on top of these transient and behavioral hazards is to have them identified on a continuous daily basis by the employees as they occur.

The organization of the hazard survey includes a review committee, contact persons in each organizational unit and checklist forms turned in by employees that identify hazards when they occur. The process includes all levels of the organization from the shopfloor to top management. At the shopfloor level employees use a checklist that identifies the nature of hazard, the location, the time of occurrence, the type of accident that it could lead to (if known), the seriousness, and recommendations for elimination or control. Employees are not required to fill in all of the information, just that which identifies the hazard and its location. However, experience with this program shows that many employees want to be involved in their own safety. Having them think about the hazards and their control reinforces employee interest, motivation, and knowledge about safety and health matters. Many of the employee suggestions for hazard control demonstrate innovation and provide cost-effective solutions that may not have been thought of by the professional safety and health staff.

To control the survey process and ensure that "real" hazards are dealt with, a bureaucracy must be established. One effective structure is to have designated persons in each work area that serve to funnel the identified hazards to a review committee that evaluates the checklist information. These designated persons are known to everyone in the work area as the hazard survey contact person who can supply a checklist on request. When emergency hazards are identified, these persons can access key safety, health, and management personnel directly, which ensures quick action to resolve the situation. For instance, if a biological spill occurs, this person can work with the supervisor to control exposure, call in medical staff, and contact the decontamination specialists. Typically, these functions are the sole responsibility of the first-line or middle-level supervison. This program provides a sharing of select management responsibilities and power with the line employees.

For hazards that are not immediate emergencies, the checklist is filled out by an employee, given to the designated person, and then forwarded to the review committee. This review committee is made up of a subset of designated persons, select safety and health staff, union representatives, a few first-line supervisors, and select managers. The review committee evaluates each hazard checklist at a weekly meeting and rates the importance of each hazard. When frivolous hazards are submitted, they are rejected. The checklist is a three-part form that provides for committee ratings and recommended action. One part of the form is sent back to the work area where it originated the day following the committee meeting. This provides feedback to the employees of the work area about the nature of the hazard, its priority, and any action that is proposed to resolve it.

This approach has several elements that are similar to the social democracy approach but which are applied differently. Cooperation between employees and management is central to effectively identifing and eliminating hazards. Employees are directly involved in the identification of hazards and thus their own health and safety. They participate through hazard identification and by serving as a designated hazard survey contact person. There is a sharing of power with employees to deal with emergencies and in making decisions about the action to be taken on identified hazards. The use of involvement and being able to have some say in the control of hazards acts as a motivational force for health and safety awareness and action by employees. It also provides a check and balance on the professional health and safety activities in a company by providing input, direction, and discussion about hazards. This keeps the professional staff abreast of current issues and problems worthy of interest. It provides a means for early warning indicators of some of the difficult to define hazards and their symptoms, such as chronic trauma, stress, and biological contamination.

But the approach has weaknesses. It can be misused by management and unions. With this approach, there is not necessarily a requirement for union involvement. Employee participation is direct and at the work area level. While there is no requirement for union involvement, for the process to be cooperative it is important to have the unions involved, preferably using the union stewards in each work area. While it is administratively feasible to have the union excluded from the review committee, this poses serious practical problems, especially when it comes to the implementation of solutions and general labor-management relations. Theoretically this approach could function properly without union involvement, but not practically. Essentially, this process has the potential to weaken important union functions, such as ensuring worker safety, by getting direct employee involvement without union input. Therefore in unionized companies, it should be a requirement for the union to be represented at the review committee level. This enhances the cooperative nature of the process and reduces the combative reactions.

There is the possibility that the union could abuse this process. In a hostile labor relations environment, when a new technology is introduced into the workplace, the union could program employees to submit many hazard checklists to create problems for management. When collective bargaining on these technology and health and safety issues breaks down, the union could use this process to harass management. This then would be an additional forum for the grievance process. Again, this undermines the cooperative spirit of this program. The program can only be effective if there is agreement between workers (unions) and management that this process is to be used for health and safety, not for collective bargaining or grievances.

Testing of the hazard survey approach in five foundries and one metal stamping company showed the increased effectiveness of this approach over state safety inspections (Cleveland, 1976). The results showed that worker identification of hazards correlated between 0.53 and 0.80 with the types of hazards causing worker's compensation injuries, while state inspector citations for violations of safety standards related to only 10 percent of the worker's compensation injuries. In contrast, this program was not as successfully implemented in the public sector (Richardson, 1973). Several public agencies, including elementary schools, a university hospital, a state mental hospital, a municipal golf course, and a state labor agency, implemented hazard identification programs in 1972 and 1973 with mixed success. In many cases, employees were not as successful in identifying hazards that reflected on the majority of workers' compensation injuries, even though they were almost always able to identify the most serious hazards that produced injuries. However, the critical element in success or failure of this approach in the public agencies was the follow-up by management on the hazards identified. In agencies where management failed to take action and to provide feedback to the employees, the hazard identification programs always failed due to reduced employee interest. This same kind of problem has been seen in other programs using employee participation. When the employee input into the process is not used, employees reduce their involvement (Lawler, 1986).

Another employee involvement approach that could be successful in addressing some of the emerging issues of new technology is the Joint Union/Management Ergonomic Committee. This was developed at the University of Wisconsin School for Workers and deals solely with specific types of hazards due to ergonomic problems (Hagglund, 1981). This approach starts with a joint training course for union stewards and line managers about the hazards of chronic trauma and possible ergonomic interventions to resolve these problems. The course covers how to recognize ergonomic hazards, how to measure the hazard potential, and how to develop dialogue and cooperation between labor and management. This training is led by a facilitator (typically a University staff person) and is conducted at the company during work hours. Employees and supervisors are given time from their jobs to participate, which demonstrates the importance of the program. One main purpose of the training is to generate discussion between line managers/supervisors and union representatives about specific hazards and worker perceptions. This give and take develops an understanding of the other person's perspective and concerns. It often generates good solutions, especially toward the end of the course when an understanding of the course technical material is integrated within the specific context of the plant.

After the training, an ergonomics committee composed of top management, select line management, and select union stewards is established that meets on a regular basis to discuss ergonomic problems and potential solutions. Employees with ergonomic problems can report them to a member of this committee, which tends to be a union steward. Semi-annual retraining is given to the ergonomics committee on emerging issues that are generated by the kinds of problems being reported at the company. This approach has been extremely successful in reducing the extent of chronic trauma in electronic assembly plants in Wisconsin.

The worker involvement and participative approaches have been very successful in improving productivity and quality in manufacturing and assembly. Some similar success has been demonstrated for health and safety problems, especially those that are easily recognized by workers such as chronic trauma hazards. The application and success of these approaches has brought about a revolution in thinking about the specific responsibilities of management and labor. These programs have succeeded where management and labor have developed a respect and trust for the contributions each can make. This is a shift from confrontation to cooperation. But, it does not occur overnight, or without some compelling force, such as the specter of a serious hazard, that establishes the need to cooperate. Trust only comes later, after a track record of mutual benefit is demonstrated. As one longtime union member at a General Motors plant put it, "It's a lot more difficult working together. When labor and management used to fight, hell, that was easy. You'd take a position and hold it—win or lose. Now it's compromising all the way through to solve problems" (Zino, 1988). Such compromise is hard when you are not used to it.

Collective Bargaining Approach

The history of labor relations in the United States is one of negotiated agreements rather than the cooperative approaches seen in countries such as Sweden that use a social democratic approach. Collective bargaining is predicated on the belief that informed and sensible parties can come to an agreement on a range of issues affecting employee well-being including occupational health and safety. Unfortunately, history has shown that the major employee well-being factors that end up in such agreements deal primarily with wages and benefits. Safety and health considerations are often included but are compromised for wage increases or benefit enhancements. Most importantly, these agreements typically do not address the "unknowns"; rather they deal with what is current knowledge. Thus, the unknown hazards of new technology do not get included, since they are not part of current knowledge.

A major union strategy for improving occupational safety and health has been to encourage state and federal governments to develop laws, regulations, and standards to control known or suspected hazards. The Mining Safety and Health Act of 1969 and the Occupational Safety and Health Act of 1970 are prime examples of major successes. In recent years, there have not been similar successes at the federal level. An example of a very recent activity has been attempts by unions to get VDT safety legislation passed by several state legislatures and introduced into the federal Congress. Recently, the passage of such a law in Suffolk County, New York, demonstrates a minor victory for this approach. Even so, the efficacy of local legislation in dealing with the potential hazards of new technology is questionable considering the long time frame, often several years, needed to get such legislation passed and implemented, and the variation in local laws are often based on compromise and not on science or health and safety considerations.

There have been other union/management initiatives for addressing safety and health within specific corporations. The United Auto Workers contract with Chrysler Corporation in 1973 called for the appointment by the company of union safety and health representatives paid for by the company and for the formation of plant safety and health committees with worker representation (Mirer, 1988). This spread to other companies in the automotive industry as contracts came up for renewal. Union health and safety representatives were trained alongside their management counterparts. This contract also provided workers with access to plant-level safety and health information and data so that they knew more about the hazards at the workplace. Mirer (1988) states, "The local health and safety committee provided an arena for problem solving, while the complaint and grievance procedure backed by the right to strike provided an arena for resolving unsolved problems."

This far-reaching agreement was the basis for more extensive cooperation between the UAW and automakers. At General Motors Corporation, the company and the UAW have undertaken a cooperative program of jointly working together on a host of issues including safety and health. In their 1987 collective bargaining agreement, "jointness" was defined as ". . . activities will be jointly developed, monitored, and evaluated" (Mirer, 1988). In his review of this program, Mirer (1988) goes on to say, "Furthermore, decisions must be arrived at in a setting which is characterized by the parties working together in an atmosphere of mutual trust: making mutual decisions at all levels which respect the concerns and interests of the parties involved; sharing responsibility for the problem-solving process; and sharing the rewards of achieving common goals."

This commitment to cooperation must be the backbone for future labor/management programs aimed at dealing with the hazards of new technology. But, before we rejoice that the battle can be won primarily by cooperative involvement, sober reflection on the diverse nature of future hazards, such as biohazards, psychological stress, and new chemicals, indicates that there is much more to be done than just working together. There is also the need for much more research, for constant vigilance, for pilot studies to catch emerging problems, and for increased federal action in a coordinated way.

Recommendations

It is my belief that the following considerations will have to become part of a new labor relations philosophy for addressing the health and safety problems of new technology:

1. Management/labor cooperation: The huge potential for disaster from the possible hazards of new technology requires that everyone contribute to hazard recognition and control. This offers a greater base of input into decisions about the nature and control of such potential hazards. Many of the new hazards will be psychological rather than physical. Such problems require a diversitiy of input to get a perspective on potential health effects. When these inputs are provided in a positive format, their acceptance is greater. Confrontation and finger pointing can be divisive and create an atmo-

sphere where action is delayed. Such delay can ultimately lead to disaster. For instance, agrigenetic products have a lifespan of less than five years. If these products pose a hazard, the nature and significance must be known quickly, and action taken quickly. Delays due to confrontation or use of standard-setting procedures slow down the control process and expose workers to unnecessary risk. Such cooperation requires an atmosphere of respect, honesty, and trust. There are current examples of how this can be achieved at a plant level, and even at a corporate or industry level (for instance, the 1973 United Auto Workers contract with Chrysler Corporation and the 1987 GM contract).

2. Management and labor must be willing to confront "problems" in a positive atmosphere. Even in the happiest of families, there are arguments and confrontations. This is healthy and provides a safeguard against abuse. The same is true of health and safety in labor relations. There will sometimes be a need to confront when cooperative efforts have stalled. The difference in this new approach and traditional confrontation is the underlying belief in the honesty of the other party and trust that they will do what is right and proper. Very few managers would willingly expose workers to serious health and safety hazards. Thus, the basis of confrontation is misunderstanding or misinformation. Therefore, the purpose of confrontation is to provide information and perspectives that can serve as the basis for cooperative, joint problem solving. Where information is lacking, then an agenda for getting the information can be cooperatively established. The sharing of health and safety information and data as specified in the 1973 UAW/Chrysler contract is the type of effort that is needed since it makes information available to everyone for the most effective problem solving. In the end, confrontation can be a check and balance within the framework of cooperation.

3. Workers must be actively involved in the process of technological innovation. First, new technology often brings psychological concerns about job future, exotic hazards, and job changes. Whether these concerns are valid or not is unimportant if they produce stress and motivational problems. Worker involvement and sharing of information with workers can reduce concerns about new technology. Second, there are certain kinds of hazards that workers are knowledgeable about. Having workers reporting these serves as a front line of defense. In addition, workers often have some expertise that can be applied to developing hazard control methods. Third, for many hazards, it is important that constant surveillance be maintained. The worker is the most logical source for this. Workers can report emerging symptoms, unusual reactions, or unexpected results from the work activity. Fourth, responding quickly to potential hazards may prevent a disaster. If workers are trained in reporting health symptoms, then it may be possible to detect hazards before they do any damage. This is especially critical for biohazards for which no health effects data is available.

Employees and unions should be included early in the process of technological innovation to provide input and expertise. This will also help in reducing employee fears associated with new technologies.

Worker training in reporting health and safety concerns is essential. Some formal training in hazard recognition would also be useful. A training format such as the labor/management ergonomic teams could be successfully used for this.

4. There is a need for constant vigilance at the workplace when new technologies are introduced to catch problems before they become serious. Cooperative efforts between labor and management will provide the climate for reporting symptoms and discomforts early. Use of hazard surveys and other techniques will provide the basis for judgments about the nature, extent, and hazard potential of any problems. National reporting systems using pilot studies and case evaluations need to be implemented to supplement current injury and illness reporting systems.

5. There is a need for special health and safety technical expertise. Many of the new technologies will produce hazards that require special expertise for examination and control. Workers do not have the technical skills for this. Management will have to develop technical staff in the health and safety program. It would be useful to provide union stewards with technical orientation as well. A model for such a program is the Workplace Health Fund "Ergonomics Training" grant from the National Institute for Occupational Safety and Health.

Government will have an essential responsibility to conduct research that will provide input to labor and management interaction. This technical information will have to be presented so that it can be understood by labor and management, and not just scientific staff. Government will also have to provide some level of compliance activity to improve safety at recalcitrant companies. The role of government will generally be consultative and informational which will support the cooperative efforts of labor and management.

Universities will need to develop more professionals to deal with the safety and health impact of new technology. Specialities in business, engineering, toxicology, genetics, epidemiology, and medicine should be emphasized.

6. A formal structure is needed for implementing the cooperative efforts of labor and management. This structure should provide for sharing of health and safety information, gathering hazard/symptom information, interaction between labor and management, and the development of expertise for defining and controlling the hazards of new technology. The structure should reflect the specific corporate approaches to labor relations and production. There is no one structure that will be best for all corporations.

7. The Occupational Safety and Health Administration should consider implementing a standard that requires all employers to have a joint employee (union)/management safety and health committee. One aspect of this committee's responsibilities would be to review the impact of proposed new technologies. This regulation would "force" the interaction needed between employees and management. Of course, the most effective interaction will occur if cooperative efforts are undertaken, rather than by "forcing" interaction through regulation. However, to guarantee that such interaction occurs in all places of employment, such a regulation is necessary.

In conclusion, the future holds great challenges in dealing with the health and safety issues of new technology. Hazards that have never been seen before, changes in work processes that may be stressful, and new angles on old hazards, all will require new solutions. These hazards will be harder to define and control. Traditional methods of health and safety programming will not be responsive to these challenges. New approaches based on labor/management cooperation and employee involvement will be needed. This is in line with new concepts of production management and quality and productivity improvement, and may be able to be integrated into such approaches. In essence, these efforts reflect a new era in labor relations.

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Discussion

In response to Michael Smith's paper, Larry McKean described the health and safety challenges resulting from federal product safety regulations that have required his firm to use chemicals with uncertain health effects. A second health and safety issue, McKean suggested, arises from the increased competitive pressure in many firms to rapidly introduce new products or materials into the workplace, hampering efforts to anticipate potential hazards.

Smith argued that the first problem reflects the absence of broad national policy and federal and state interagency consensus and coordination in monitoring the relationship between technological innovation and safety and health. Any discussion of biological, chemical, psychological, or physical hazards involves a number of different agencies, rather than OSHA alone. Moreover, Smith suggested, the necessary expertise for reviewing and monitoring the health and safety effects of new technologies is scattered. Greater efforts on the part of educational institutions in particular are needed in order to provide training and expertise. As for the rapid prototyping of chemical products and products containing new chemicals and other substances, Smith said that these pressures are common in a number of industries, asserting that

> **policymakers just don't have the knowledge and background to make good decisions.**

Sheldon Friedman (Research Director, UAW) supported the idea that new technology is a mixed blessing from the standpoint of health and safety in the workplace. Friedman cited the example of spot-welding robots, which reduce workers' exposure to hazardous substances such as lead, yet can create new hazards, including the risk of robot-inflicted injuries and even death among the workers who maintain them. Another practice, computer monitoring of workers, raises a number of serious questions. The Congressional Office of Technology Assessment has estimated that 7 million U.S. workers are subject to computer monitoring. Friedman suggested that this practice increases the stress level of many jobs and also can represent an invasion of privacy and an assault on dignity. In its 1987 bargaining with one of the major auto companies, the UAW negotiated contract language that prohibited the use of computers to monitor workers for setting production standards or supporting disciplinary actions. This collective bargaining breakthrough for the UAW, however, has not spread very far yet.

To help deal with the problems created by the introduction of new technologies, Friedman said that discussions and joint health and safety initiatives involving the UAW and major employers have been highly successful and have led to the development of important training, research, and ergonomics programs. Nevertheless, these private sector labor-management initiatives are undercut by a lack of government support for new health and safety regulations and for the enforcement of existing regulations:

> **That is really the critical problem . . . the weakened enforcement . . . the cutbacks that have occurred in the budgets for those programs. . . . These are all very serious problems, and they couldn't come at a worse time given the pace of technological change. . . .**

Early involvement of unions and workers in the planning and introduction of new technologies also can improve the design and organization of jobs and work as well as workplace health and safety. By the time the decision is made by managers to purchase and install a specific type of equipment, Friedman noted, problems with health and safety, job content, and workplace stress that could have been avoided may instead be locked into place. These problems are still more acute in firms in which workers are not represented by a union:

> **Maybe we need to start thinking about public policies that would require companies to have safety committees, even if they don't have a union, that would give workers meaningful input. . . .**

Commenting on the role of safety committees, Linda Lampkin (Research Director, American Federation of State, County, and Municipal Employees) reported that some 70 percent of AFSCME's local unions have safety and health committees. She contended, however, that many of these committees have little power:

> **They are used as a vehicle. . . . Management says, 'We won't deal with this at the bargaining table. We will set this health and safety committee up, and then we won't have to deal with this problem.' And it is a way to let the union blow off steam and not affect the economics or the day-to-day bargaining. It is very good to talk about the lack of information and the need for training, but the union wants more involvement and more participation in something that is really a power struggle . . . going on over both the training issues and . . . how they [jobs] will be designed as well as the health and safety aspects of it. . . .**

As an example of a significant joint union-management effort in the realm of health and safety, Morton Bahr described an invitation from Bell Labs to the Communications Workers to work with ergonomics researchers in designing video display terminals. This joint initiative improved the design of work stations and yielded design standards that the union uses in dealing with other employers. With regard to computer monitoring, Bahr noted that if corporate management did not move to address abuses, federal legislation was likely to be enacted.

In comments prefiguring a central point in his paper with Richard Walton, Robert McKersie noted that computer monitoring illustrates the dual potential of many new technologies to either extend employer control over workers in an essentially "Tayloristic" fashion or to enhance and improve workers' decision-making autonomy and control over their jobs:

> **In fact, there are some offices where the workers don't mind being, in a sense, observed as long as the feedback comes very quickly and it is constructive and problem solving. So, it is a very complicated subject, and it just points up how technology, in this case information technology, presents some really dramatically different alternatives, and it really then gets to the question of how management and the union, if there is a union present . . . work out a strategy for dealing with the power that is now present.**

Following up on Sheldon Friedman's comments, John Read argued that the management of the introduction of technology into the workplace, rather than the collective bargaining environment alone, plays a key role in the health and safety area. The application of technology in many companies, he contended, is effectively determined by technicians and engineers who may have little interaction with the managers or workers who must utilize the new equipment or manage the new plant. In some instances, line managers, employees, local union leaders, and company human resources managers do not even see the technology until it is ready for implementation. In order to integrate the technology with the human resource issues, which include more than health and safety alone, a broader planning effort must begin well in advance of the commitment to a specific process technology or equipment.

John Stepp expressed concern over the outlook for health and safety based on the comments thus far in the discussion. The development and implementation of new technologies are occurring more rapidly than heretofore in many manufacturing and nonmanufacturing firms. These technologies and the accelerated pace of their introduction create greater demands for expertise in health and safety areas. At the same time, shifts in the structure of the economy appear to be changing the nature of the workplace in ways that make it more difficult to enforce existing regulations and standards:

> **. . . many of the new jobs [are] being created in this country in small companies with inadequate resources, the vast majority of which are not organized. So, there is not a union to play that protective role, and clearly there are very limited federal resources. I think we have slightly over 1,000 inspectors across the country in OSHA now, . . . inadequate by anyone's measure. Yet, we are being confronted with this rapid deployment of much more sophisticated technologies. It doesn't seem to me that inspection after the fact is likely to produce the desired results.**

Stepp suggested that the experiences of other industrial nations may provide some useful guidelines for U.S. efforts to deal with this challenge. Michael Smith cited the example of Sweden, where union-management "codetermination" (including union representation on corporate boards) seems to give health and safety issues a higher priority. The safety and health experts in a Swedish plant, he pointed out, often operate with considerable independence from management. This may increase workers' willingness to report problems as they occur. Smith expressed pessimism about the prospects for an innovative federal policy in the U.S. for health and safety issues. He believed that any such initiative would require sustained pressure from labor and management, as well as demonstrated success in joint efforts.

Several other participants discussed health and safety regulation in other industrial economies. Lynn Williams reported that the province of Quebec requires joint health and safety committees in enterprises above a specific size. The law also provides that health and safety standards must be established under the supervision of a joint committee in which labor and management have equal representation. Gunnar Westermark (Director and Head of the Labor Market Section of the Swedish Employers' Confederation) observed that in Sweden high health and safety standards are regarded as a means to increase efficiency but, even more importantly, provide an effective way to recruit good workers. Especially in the Swedish economy, where the labor force is growing slowly, attracting young workers requires that a firm demonstrate a serious commitment to a safe workplace.

John Read commented on the Quebec system of mandatory health and safety committees, expressing concern about providing workers with powers to evaluate safety and health violations. Any shop-floor process of codetermination that gave workers such broad authority must also train them to make such judgments. The answer to health and safety problems in the adoption of new technologies, he contended, lies more in the effective integration of health and safety concerns with the broader processes of decisionmaking on new technology adoption, in developing and enforcing philosophies at the top and actions at the bottom of an organization that make such integration a requirement.

Linda Lampkin suggested that increasing awareness among the general public of the potential effects of toxic chemicals and other hazards gives unions greater leverage in dealing with health and safety issues:

> **[In] the drive for community right-to-know laws, we have won some arguments about the kind of pesticides that our park workers use because the public walks by those parks, sits on the benches where they have just sprayed stuff that is similar to Agent Orange to kill the weeds.**

John Stepp posed a broad question regarding U.S. labor law, noting that the majority of the group agreed that "Taylorism" is outmoded as a philosophy of work force management, particularly insofar as it assumes that the work force is composed of two mutually exclusive groups—thinkers and doers. He contended that Taylorism nevertheless is embedded in federal law:

> **. . . In 1935, with the passage of the Wagner Act, we incorporated Taylorism into our national labor policy. . . . Can we get rid of Taylorism and keep our present labor-management model?**

Lynn Williams agreed that Taylorism is outmoded, but argued that an adversarial relationship between labor and management is inherent in the fact that "owners still own and workers don't, and at some point in this process you have to determine how are we going to share the economic fruits of this successful enterprise." Collective bargaining should be a rational problem-solving process, rather than a highly emotional confrontation, he suggested, but it should not be rejected as a fundamental component of labor-management relations. Morton Bahr noted that the adversarial tone of labor-management relations can be improved or moderated in many instances by conducting discussions between contract negotiations that focus on problem solving; among other things, this approach means that many issues receive the attention of management and union leaders before contract talks.

Joseph Mahon agreed that the National Labor Relations Board (NLRB) tends to pursue a very legalistic approach to labor-management relations in its decisions, rather than exploring new approaches. Jack Barry (President, International Brotherhood of Electrical Workers) expressed an alternative view, arguing that the Wagner Act contains more flexibility than many unions or managers sometimes suggest:

> **. . . the adversarial approach to labor-management relations in this country has worked very well for the country and for the workers in this country, both unionized and non-unionized. . . . I think that Taylorism has proven to be detrimental to the interests of the country and to the workers and to the companies. So, I think that we can proceed under the auspices of the Wagner Act continuing to reject Taylor, and as companies and some labor unions do, grant exceptions to the Wagner Act.**

Managing New Technology and Labor Relations: An Opportunity for Mutual Influence

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New technologies are often essential to the effort of enterprises to become more competitive. How the technology is introduced, in particular how labor-management issues are handled, will strongly influence whether the new technology makes its potential contribution. The purpose of this paper is to outline briefly what we have learned over the past decade about this subject.

We need to distinguish at the outset between two broad workforce management strategies, because what we have been learning applies more to one of these strategies than the other. We label one of these strategies "mutual compliance" and the other "mutual commitment" (Walton, 1987a). We propose that these alternative approaches to workforce management influence the design of technology as well as the way it is implemented. Conversely, we propose that the design and implementation of new technology can be a powerful force toward either a compliance or commitment organization.

The traditional employment relationship assumes no more than employer and employee compliance. Each agrees to comply with certain terms of employment, either prescribed or tacitly understood. Under mutual compliance employees are expected to give a fair day's effort for a fair day's pay, and management is expected to supervise this bargain in a firm but fair manner. Mutual commitment goes well beyond such a traditional arrangement. The employee becomes committed to the organization and its goals, which is matched by additional commitment by the employer to the employee's welfare. Employee commitment takes many forms, including initiative to improve quality, reduction of scrap and other waste, and an increase in the productivity of their own labor. Similarly, the organization's commitment to workers can be expressed in a variety of ways, including strong employment assurances, opportunities to participate in decisions, and programs for training and retraining.

Many organizations continue to rely upon control and compliance techniques that have been perfected over many decades—clear demarcations between planning and executing, narrow and deskilled jobs, individual accountability, standards of minimum performance, close supervision, and labor, in general, treated as a variable cost. While these techniques often are depersonalizing and demotivating, their adverse effects may be minimal in practical terms; moreover under control conditions, the organization has circumscribed its dependence on the competence and internal motivation of the individual. Therefore, some corporations and government agencies still regard mutual compliance as the most practical approach available to them for managing at least a fraction of their work force.

While a few companies have practiced mutual commitment for many decades, the trend toward relying upon policies that elicit employee commitment and less on ones that impose control really began in the early 1970s, as management sought to extend to other workers an approach long idealized in relations with the professional work force—challenging work, self-supervision, open communication, and mutual influence. In effect, labor is treated as a resource to be developed rather than as a variable cost.

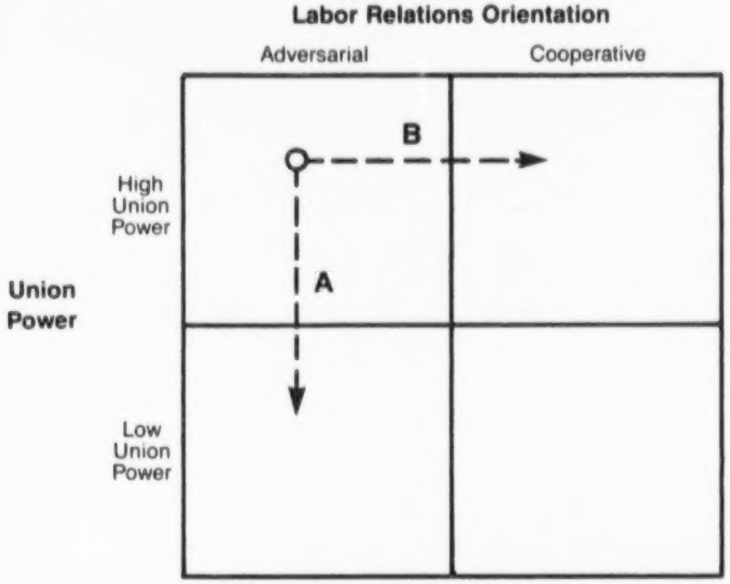
The above distinctions are important for the present discussion of new technology. The choice between contrasting management strategies—control versus commitment—will determine the labor relations dynamics that will be encountered in the process of introducing new technology, and therefore the steps that are appropriate in order to make the process as constructive as possible. Also, some of the new workplace technologies, especially those utilizing advanced information technologies, usually can be exploited more effectively with the mutual commitment approach than with control and compliance. Therefore, while we will also discuss the dynamics and techniques associated with new technology introduced into a stable framework of mutual compliance, we will emphasize situations where management is attempting to initiate or strengthen a commitment organization.

Mutual compliance is found in both nonunionized and unionized companies. Similarly, mutual commitment is being pursued in companies that do not deal with unions as well as those that do. Often the mutual commitment approach is jointly sponsored by management and union.

Management's approach to its work force, which we have been discussing, and its strategy for dealing with unions are closely related. Beginning in the mid-1970s, American management's strategies toward unions developed along two contrasting paths. One strategy attempts to weaken the union, permitting management to manage as it sees fit. The other strategy attempts to expand the area of cooperation between management and the union.

These two strategies are alternative approaches to the same compelling problem confronted by management—a lack of competitiveness. Management's predicament is aptly portrayed in the framework in Figure 1 (Walton 1987b). Consider that

Figure 1



Strategy A- Attempt to weaken union power in order to secure deep economic and work rule concessions; and accept adversarial relations.

Strategy B- Attempt to generate a cooperative relationship with union in order to support participative improvements in quality and productivity; and accept that economic concessions and formal work rule modifications may be modest.

management's relations with its union can be either adversarial or cooperative (or some point on the spectrum defined by these end points) and that the union can either have high relative power (meaning it can effectively prevent management from doing much of what it would like to do) or low power. Union-management relations in many American industries had become firmly established in the adversarial/high union power quadrant during the 1950s and 1960s. As long as American auto makers and steel companies, for example, were only competing with other domestic producers who had similar labor relations, this condition created no serious competitive problems. However, once these companies confronted tough foreign competitors in the U.S. market, their managements began to recognize that the combination of powerful unions and adversarial relations was a noncompetitive position.

Two routes are available to escape this condition. The first is to attempt to weaken the unions' power and accept the possibility that adversarial attitudes may be intensified, at least for a period of time. This route is best dramatized by an example outside the private sector, namely President Reagan's actions to break the air traffic controller strike and the PATCO union, but it also is exemplified by actions taken by Continental Airlines, Phelps Dodge, Greyhound, and perhaps USX.

The second escape route is for management to accept the union's strength and to attempt to transform the relationship into one that emphasizes the parties' mutual interests to strengthen the competitiveness of the enterprise. This strategy has generally characterized the relations in recent years between Ford and the UAW, LTV and USW, AT&T and CWA, and Xerox and the Amalgamated Clothing and Textile workers (ACTWU)—to cite several examples.

Different advantages and disadvantages are associated with these contrasting strategies. By attempting to confront and prevail over the union, management usually seeks deep economic concessions and work rule changes. However, the adversarial climate usually is not conducive to initiatives by management to enlist employees in other productivity improvement activities. In contrast, by attempting to structure collaborative relations with its union, management hopes that it can implement commitment policies and practices and enlist the spontaneous cooperation of employees in performance improvement activities. With this strategy economic concessions and formal work rule changes usually are relatively modest, at least in the short term.

For it to be feasible to pursue the mutual commitment approach, the parties have to be able to take a long-term view. For the company this means that short-run, economic pressures are such that it can resist the tendency to go for quicker but qualitatively inferior solutions. For the union, this means that the leadership must enjoy sufficient security so that they can cooperate with a program of change without being voted out of office.

The Mutual Compliance/Adversarial Scenario

Certain patterns characterize the introduction of new technology into companies that adhere to a mutual compliance approach for at least part of their work force and that accept an adversarial relationship with the union, if one is present (Walton 1985). Managers tend to be preoccupied by technical and economic criteria and deal with social issues only if and when the reactions of employees or unions require action. Unions attempt to impose conditions on implementation in order to limit the technology's adverse effect on the work force, e.g., slowing the introduction to ameliorate employment effects, grieving working conditions for health and safety reasons, enforcing bidding procedures to protect traditional seniority rights, and protesting technology-based monitoring in order to reduce job pressure.

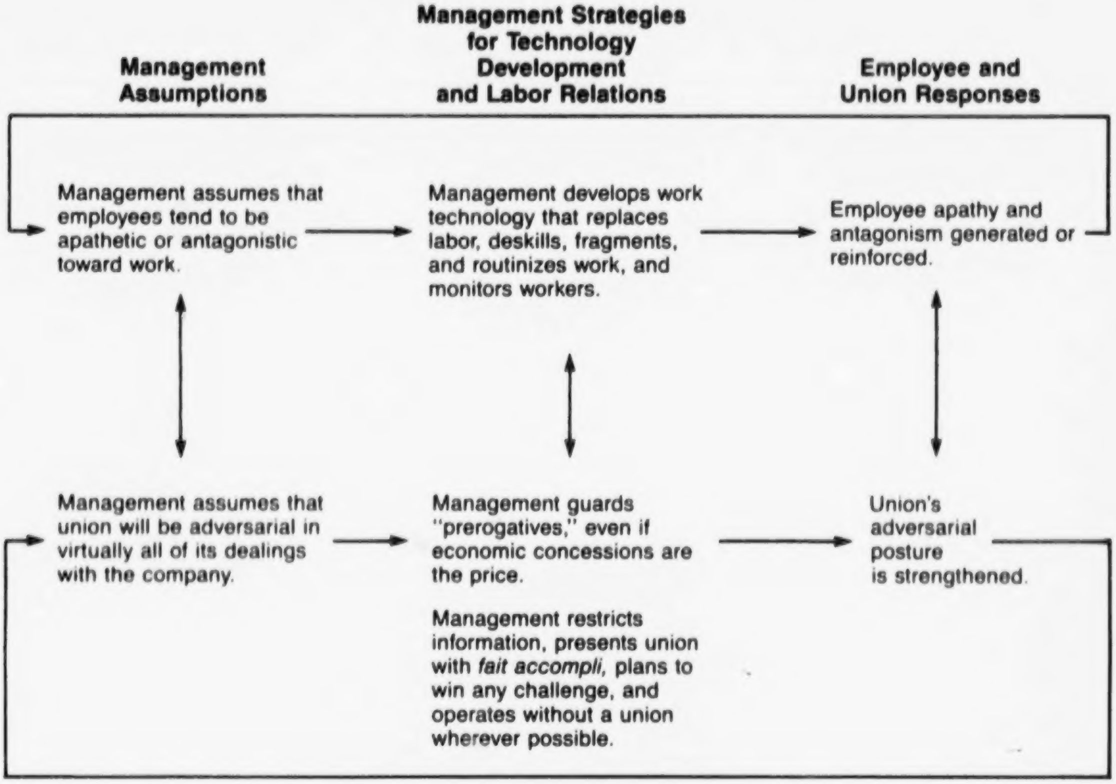
Responding to—or anticipating—employee and union resistance, management adds social control to the other criteria that shape the design of new technology and generally intensifies the adversarial battle over managerial prerogatives. Management finds itself in one or both of the self-reinforcing cycles depicted in Figure 2. In mutual compliance situations, managements tend to hold pessimistic assumptions about workers' motivations and skills. These assumptions lead management to develop technologies that deskill and routinize work, which in turn generate worker apathy or antagonism, thereby justifying management's earlier assumptions and its control strategy. The development of intensely adversarial labor relations in many unionized companies has reinforced the dynamics surrounding technology design. An assumption of adversarial relations by management leads it to pursue objectives and utilize tactics that increase the union's tendency to challenge and constrain management actions.

Each of the two self-reinforcing loops depicted in Figure 2 is robust by itself, but in combination, they are especially formidable. For example, preoccupied with its position in an adversarial union relationship, management will be especially interested in work technology that deskills jobs, controls workers more closely, and permits the removal of tasks from members of the bargaining unit, because these effects will increase management's operational flexibility and minimize certain labor relations "hassles."

By way of elaboration, the dynamics associated with mutual compliance and adversarial relations lead to the following patterns of work-technology

Figure 2

Management of Technology and Labor Relations Some Self-Reinforcing Dynamics



Management Assumptions

Management Strategies for Technology Development and Labor Relations

Employee and Union Responses

Management assumes that employees tend to be apathetic or antagonistic toward work.

Management develops work technology that replaces labor, deskills, fragments, and routinizes work, and monitors workers.

Employee apathy and antagonism generated or reinforced.

Management assumes that union will be adversarial in virtually all of its dealings with the company.

Management guards "prerogatives," even if economic concessions are the price.

Management restricts information, presents union with *fait accompli,* plans to win any challenge, and operates without a union wherever possible.

Union's adversarial posture is strengthened.

Source: R. Walton, 1985, p. 208

development:

First, in the design of new work technology, jobs tend to be deskilled, fragmented, and routinized. This increases management's control over the work force, but the new jobs also demoralize employees and limit the positive contribution they can make to service and cost effectiveness.

Second, as new technology is designed and implemented, the full potential of retraining employees is seldom realized, even though such retraining could be advantageous to both the company and the employees. In addition, management fears that contract provisions will force them to fill positions with unqualified persons.

Third, the design of new technology sometimes moves tasks out of the bargaining unit. This shift may give management certain tactical labor-relations advantages, but it assigns to professionals and supervisors work that neither uses nor develops their potential and takes away from workers in the bargaining unit some work that would have utilized and developed their potential.

Fourth, electronic monitoring capabilities are built into the work system that may ensure achievement of minimum performance but that discourage workers from providing any more than the minimum.

What advice can be given to planners of new technology where the employee-management relationship is for some reason locked into a mutual compliance pattern and the union relationship, if one exists, is locked into an adversarial mode? In a competitive business environment it is still in the interests of all parties to make effective use of new technology. It is clearly in management's interest to minimize employee resistance to the new technology.

The ingredients of effective introduction of technology in this scenario include: (1) careful communication by management of the competitive rationale for the technology and the implementation plans; and (2) practical compromises that respond to workers' major concerns, such as advance notice and buffering the employment and income effects of the technology, and at the same time ensuring that workers comply with major operational priorities, such as the staffing patterns for new technology.

Another ingredient is adequate training of the users to operate the new technology. Certainly, training is a key intervention for the mutual commitment/cooperation scenario that we will consider shortly. But training also serves an important function in the mutual compliance situation, namely, to set the stage for holding the workers accountable for specified results because they have been instructed in the relevant knowledge to operate the new equipment.

Most fundamentally, however, we advise managements and unions presently in the compliance/adversarial scenario to continue to explore the feasibility of moving in the direction of mutual commitment and cooperation. The reasons for this recommendation will become apparent in the discussion of the commitment/cooperation scenario.

The Mutual Commitment/Cooperation Scenario

Advanced information technology, which is integral to most new work technologies today, is strengthening management's incentives for creating a commitment organization (NRC, 1986; Walton and Susman, 1987; and Zuboff, 1988). The nature of computer-based work technology has been changing in a way that places a higher premium on an internally motivated and intellectually competent work force. The trend has been away from automation applications that simply substitute capital for labor toward more complex applications that augment the role of labor in the production process or the delivery of services.

Computer-based work systems primarily oriented to cost reduction often attempt to automate as completely as possible functions previously performed by individuals. In contrast, systems oriented to adding value (by increasing effectiveness or generating new products) often emphasize a dynamic interaction between the technology and its users, including the generation of new information by the system to be used in cognitively complex ways by the users. Zuboff (1985) has referred to these options as "the two faces of intelligent technology" and labelled them "automate" and "informate." By automate she means: "the application of technology that increases the self-acting, self-regulating, and self-correcting capacities of systems." In contrast, informate means "the application of technology that translates objects, events, and processes into data and displays that data." She has demonstrated in a convincing way how these two technology strategies have profound implications for the nature of work and power relations in industrial society (Zuboff, 1988).

Sharply different types of organizational requirements are associated with different forms of information technology. Technology that is almost exclusively designed to automate operations usually reduces both headcount and the dependence of the production system on the judgments of the remaining operators. It is likely to reduce the amount of training operators need. Under these conditions of automation adequate performance can often continue to be obtained by close supervision and control-oriented organizational rewards and punishments.

A contrasting organization is needed when new technology is designed not only to automate certain functions (including storing, retrieving, and manipulating information) but also, and more importantly, to provide operators with new forms of information to upgrade their decisions and the goods and services they produce. For this type of technology to be operated effectively, the human resource policies and practices must elicit a high level of spontaneous commitment, provide for higher level cognitive skills, and encourage substantial influence on the part of those who operate the new system.

A case in point is computer integrated manufacturing (CIM). A National Research Council (NRC) committee composed of executives, labor leaders, and academics and chaired by one of the authors studied human resource practices in 16 state-of-the-art installations of advanced manufacturing technology in the United States (NRC, 1986). A majority of these installations were computer integrated manufacturing systems. The committee found that certain features of this advanced technology make a number of high-commitment practices especially appropriate. For example, elements of the manufacturing system become more closely coupled with CIM technology. The tighter interdependence of tasks makes broader jobs and more flexible assignment patterns extremely advantageous. In addition, the more integrated the system, the more alert and ready to act workers must be. Therefore, it is crucial that workers be *internally* motivated.

As indicated earlier, close supervision can compensate for lack of motivation where the technology involves repetitive, short-cycle activities, but it cannot obviate the need for individual responsibility in the complex CIM environment. Fortunately, the increased capital intensity of CIM and the smaller crew typically required to operate it make it easier for management to devote the time and resources to develop high commitment.

Therefore the advanced forms of computer-based work technology are more effectively exploited by commitment organizations. Many forms of advanced information technology not only depend for their effectiveness upon users who are internally motivated, but they must be designed and managed in a way that elicits that type of motivation. Advanced information technologies not only benefit directly from an operator's understanding of the unit's business; they also can impart such understanding. These technologies not only require continuous learning; they also promote and reinforce it.

However, whether these potentially positive relationships between a general commitment orientation of the organization and the new technology are realized depends upon how the technology is introduced and managed. The following are offered as constructive practices.

Articulate Organizational Ideals

In an increasing number of corporations, top management has formulated a vision of the type of organization which it believes will enable the corporation to compete. For example, these visions often call for some combination of the following: fewer levels of management, delegation of decisions to the lowest level where information and expertise can be provided, more teamwork, more entrepreneurial spirit, more self-supervision, and a stronger customer service orientation. It is our contention that a new technology can either promote or frustrate the movement toward some of these ideals, depending on how it is designed and managed.

The existence of an explicit statement of ideals, whether it is called a management philosophy or an organizational vision, can serve as a set of social criteria to guide the development of new technological systems. These social criteria can be applied in the approval and assessment processes in a way similar to technical specifications and economic justification.

Unfortunately, even corporate organizations that have clearly articulated philosophies and use them to drive quality of work life efforts and other organizational development activities seldom ensure that they are applied in the design and implementation of new technology. Thus, in the early 1980s when AT&T was trying to revise its managerial style to be less controlling, and was sponsoring QWL activities jointly with the Communications Workers of American (CWA), the Bell Labs and AT&T central staffs were designing automated technologies and computer-aided administrative systems that ran counter to these new ideals. The automation deskilled, routinized, and paced workers and more closely monitored their behavior. Such an experience is not atypical. American managers and union officials generally have been slow to appreciate that technological choice is social choice. They fail to appreciate that *many* technical solutions exist for a given economic problem, and that each technical solution has a unique set of social consequences. Therefore, education about the relationship between organizational and technological choices is needed for line managers, systems developers, human resource managers, and union officials. Both private and public sector institutions should give priority to responding to this need for new understanding of these important relationships.

Address Threshold Issues

Certain issues are often so crucial in determining the response of employees and their representatives to new technology that they should be addressed in policy terms, ideally in advance of any specific new technology project.

The first threshold issue is employment security. No other aspect of the context for implementing new technology is more important than the presence or absence of assurances about employment. Workers hold similar concerns whether we are talking about non-union or unionized workplaces, although the presence of a union usually ensures that employment security issues and their relationship to new technology are addressed more explicitly. The NRC study concluded that "to build and preserve human commitment and skills required to operate advance manufacturing technology, the policies that govern employment security and ease labor dislocations must be as favorable as the competitive circumstances of the enterprise permit" (1986, p. 4). Robert Zager's paper in this volume, "New Technology and Continuous Learning," outlines innovative practices in this area.

During the 1980s we have seen the evolution of a number of key principles of employment security in several bellwether collective bargaining agreements. In the auto industry, the employers have agreed to the premise that no layoffs should occur as a result of the introduction of new technology. Management has been willing to agree to this principle since it can control the pace of technological change and the displacement effects for the work force can be planned for and handled via a variety of redeployment efforts involving job banks, retraining, transfer, and even outplacement to work in other industries.

Another principle that has emerged recently in some labor agreements is that before work is moved out of the bargaining unit (e.g., subcontracting, shift to overseas operations, etc.), the workers whose jobs are at risk should be given a chance to form task forces to study the situation and to formulate a restructuring plan for their operations so the in-house costs come within range of the competitive benchmarks. Xerox and the ACTWU have followed this procedure with the result that a number of departments have "saved their jobs."

This last-mentioned point helps deal with the concern that is often voiced about employment security, namely, that it creates a dichotomy between the core work force that is part of the mutual commitment system and a more marginal work force that may not enjoy employment security. To the extent that employment continuity is generated by the actions of the work force to devise means to keep work in-house, then the resulting benefit seems more acceptable because it has been earned rather than being conferred at the expense of some buffer group.

A second threshold issue occurs in a unionized context. It relates to the effect of new technology on the bargaining unit. New technology often changes the nature of work so fundamentally that it creates ambiguities about whether the new tasks are appropriately placed within or outside the bargaining unit.

Recall that in the adversarial scenario both parties view the introduction of new technology as an opportunity to redefine the effective scope of the bargaining unit in their favor. In the cooperative scenario, they are more likely to address other issues without emphasizing where work ends up in relation to the bargaining unit. For example, if management is otherwise trying to delegate functions to lower levels of the organization, it may willingly move new activities such as programming and new decision-making responsibilities into the work of bargaining unit members. Similarly, if some computerized functions previously performed by bargaining unit members are now more naturally packaged electronically in the work of supervisory or professional personnel, the union is relaxed about that outcome.

This can be a highly sensitive issue. The important point is to recognize that management's willingness to embrace more work in the bargaining unit depends in part upon the prospects for union-management cooperation, and that the union's readiness to enter into a cooperative relationship depends upon management actions that respect the integrity of the bargaining unit.

As the traditional demarcation lines between blue-collar, white-collar, and professional work become blurred, a number of tension points and opportunities are presented to the parties. In an instrument factory studied by one of the authors where a compliance pattern existed, the following sequence occurred. When first generation technology was ordered from the vendor, the break-in and customizing were performed by the operators, all members of the IAM local. As more specialized and advanced equipment began to be introduced, the company found it necessary to perform the customizing work in-house but decided to have it be performed by specialists located in the "model shop"—not a part of the bargaining unit. Conceivably, the equipment operators could have been trained in the advanced skill areas of electronics and optics, but the company chose to maintain (and even intensify) the adversarial relationship with the union—in part, because this was the only unionized plant of this multi-plant company, and the corporate approach emphasized containment (and if possible shrinkage) of union influence.

Contrast this example with the experience of Cummins Engine and its independent white-collar union. With the same trends mentioned above, more and more work was naturally falling within the domain of engineering associates, a position not normally within the bargaining unit of technicians. The solution reached by the parties was to include the engineering associate position in the bargaining unit (a gain for the union) but not cover it with the existing bargaining contract provisions (a gain for management) (Cappelli and Sherer, forthcoming).

Initiate a Constructive Climate

Many steps in addition to those described above can serve to create a climate generally favorable to the introduction of new technology. We will discuss several.

Employment security may relieve some of the anxiety associated with technological change, but many employees are anxious about their ability to operate in the new computer-based environment. An IBM facility with which the authors are familiar provides an example where management either encouraged or supported a large fraction of the work force to become educated about the information technologies that would in the future become the bases for new work processes and jobs. The positive motivational effect of this education was at least as important as the enhanced competence it produced. Motivation and competence were, of course, both important dimensions of the social context for the specific new technology projects.

Some of the most powerful initiatives for creating a social context favorable to new technology are those that involve employees directly in problem-solving activities designed to improve the working environment and performance. These activities, encouraged under such umbrella concepts as quality of work life (QWL), employee involvement (EI), participative management, and quality circles, help develop the increased social and cognitive skills and the attitudes of self-confidence and self-reliance that will contribute to effective use of the new technology. Naturally these positive effects occur only when the activities reflect the genuine commitment of management to the spirit of participation, are also sponsored by the union if one is present, and are accompanied by other supportive changes such as training. The value of establishing a pattern of employee participation as a prelude to the effective introduction of new technology was confirmed by the NRC study and has been demonstrated in other experiences of GM, Ford, AT&T, and Cummins Engine with which the authors are familiar.

Management initiatives to change its relationship with unions usually must occur in parallel with those designed to involve employees. Illustrative are the Common Interest Forum (CIF) initiated in a number of union-management relationships, including those involving UAW with GM and Ford and the CWA with AT&T.

In the case of AT&T and CWA, the parties agreed in 1983 to institute CIFs in the many separate entities of the Bell System. The forums have been used in practice in varying degrees. The CIF at Pacific Bell became a major vehicle in 1985 and 1986 for jointly addressing employment security issues and for expressing a new "business partnership" between the parties (Kanter, 1988). Local CIFs were established to deal with other matters including the introduction of technology. The CIF was also the setting for developing joint AT&T–CWA training and retraining efforts, finalized in one form in the 1986 collective bargaining agreement as a non-profit organization, the Alliance for Employee Growth and Development. AT&T committed $7 million per year to the Alliance.

Based on these and other similar experiences, the CWA Executive Board Committee reviewed the general requirements for moving its relations with management from adversarialism to cooperation and the specific contributions that CIFs can make, and concluded:

> **This cooperation between union and management depends in large part on management's attitude to the union. Cooperation must be a two-way street. Just as the union leadership must understand and respect the company's need to remain profitable and competitive, so the company must understand and respect the union's need to further the goals of members and to organize new members. Companies cannot form non-union subsidiaries at the same time they expect the union to support their competitive strategies. Both company and union need to trust each other so that management does not undermine the union and the union does not hold mutually beneficial programs hostage to collective bargaining demands.**
>
> **Ongoing Common Interest Forum discussions can build understanding and deal with differences in a non-adversarial manner. The union will be better able to serve its members and help the company's position if it has an early knowledge of and a voice in company strategies that affect employment, work processes, and life on the job. This requires that union leaders talk directly to the line managers who make these decisions before they are made. This cannot be achieved if the union related only to the Labor Relations department. While management leaders in Labor Relations took the lead in bringing the union together with line managers, the CIFs must include line managers. In similar fashion at local levels, the CIF works only when local CWA leaders develop a working relationship with line management (CWA Resolution, April 14, 1988. p. 4).**

A concrete example of how the common interest forum approach works in practice comes out of the experience of Pacific Northwest Bell and the CWA. The position of systems technician had experienced considerable change as a result of new technology and testing procedures. The initial approach to upgrading skills emphasized individual learning with a battery of tapes and learning modules. A number of technicians expressed via the work relations survey a need for a different approach to new skill acquisition. As a result, a task force was created consisting of technicians appointed by CWA, line managers, and representatives from the local vocational educational system. As a result of the recommendation of this group, a telecommunications course was started on company time for any technicians who volunteered. It has been very successful and a followup course has been launched (Hilton and Straw, 1987).

It is clear that a mutual influence approach can have substantial benefit for incumbent workers whose skills need to be upgraded in the face of new technology. But does such a strategy also apply to entry workers in low skill industries, such as the service sector where many new jobs are being created? We believe so. Even the service sector is experiencing the infusion of new technology and new work organization ideas such as teams. Consequently, the themes of involvement and career enhancement also apply to a "low-tech" industry.

Management sometimes uses improvements in the union relationship as a criterion for deciding whether to invest in new technology in a particular plant. It may also use the prospect of the investment to induce the union to agree to special conditions favorable to the implementation of the new technology. For example, when Allen-Bradley started up a computer integrative manufacturing (CIM) facility in April 1985 to manufacture contractors and relays, it wanted to manage the system with innovative organizational and human resource practices (Goldstein and Klein, 1987). UE officials agreed to give management carte blanche in designing the CIM work organization during the pilot stage of the project because they wanted to encourage the company to place new technology in established unionized locations rather than greenfield sites. The parties subsequently agreed on such matters as job classifications and selection procedures when the system was moved from the development unit to the production department where it was covered by the union contract.

This arrangement between Allen-Bradley and the UE illustrates another condition helpful to the introduction of new technology, namely a willingness to give planners space to experiment and learn. In this case, both management and the union could withhold judgment about what departures from their conventional working arrangements—job classifications, flexibility of assignments, pay systems, and selection criteria and procedures—would be operationally desirable and politically acceptable. They could learn from experience the operational advantages of certain practices and workers' reactions to them before deciding which of them to institutionalize for the CIM system.

The Allen-Bradley example also illustrates the reciprocal relationship between technology and social variables, in this case the tenor of union-management relations. The introduction of new technology is certainly influenced by the extent of cooperative labor-management relations—but the occasion of new technology introduction also provides an opportunity to create new arrangements and understandings which help elaborate mutual commitment that may only be at a formative stage.

Structure Participative Planning, Implementation, and Assessment

User involvement has long received at least lip service by technology developers. The concept is being broadened to call for the participation of not only users but other stakeholders in the process, and not only in implementation activities but also in the design process. Participation can take many forms, as the examples below illustrate.

The NRC study found that employees are sometimes involved as early as the selection or adoption decisions involving new technology. At five unionized sites included in the NRC study, workers or union officials accompanied engineers on trips to vendors and rendered opinions on what equipment to buy. Employees and union representatives also were consulted on how to operate the equipment and how to organize the work.

When the union is consulted early in the technology development process, it is more likely to become an advocate for the new technology, reassuring union members that the technology will secure more jobs than it threatens. Union officials who participate in the selection or preliminary implementation process do this recognizing that they may be taking political risks in order to serve the long-term interests of their members.

Since new technology may increase the job evaluation point value of the impacted jobs, some union leaders are reluctant to become involved at the design stage for new technology for fear they will become co-opted and unable to represent member interests when the bargaining issues come on the table.

At Boeing, this dilemma was resolved by instituting an annual technology briefing for top IAM officials. Long-term trends in CAD/CAM, robotics, and composite materials were dealt with in these annual sessions. However, for specific technology projects union officials were not involved at the strategic stage, thereby leaving them free to pursue the distributive issues of staffing and pay levels.

Deal with Potential Constraints

We have mentioned the many aspects of the organization that may need to be redesigned—including jobs, pay schemes, selection procedures, training, structure, and performance management. The ideal organization can be introduced readily in a greenfield site with a new work force in a favorable labor market. More typically new technologies are introduced into more constrained environments requiring adaptations. We treat here how constraints may be imposed by union contracts on the one hand and the existing skills and attitudes of supervisors on the other.

Unions often limit to some extent the flexibility that is otherwise appropriate for operating new technology, precluding for example the integration of operating and maintenance work. The union principle of seniority also often constrains the selection process. Where the technology raises skill demands, increases capital intensity, and renders the system more sensitive to mistakes, effective utilization of manufacturing technology is more dependent than ever on selecting the best talent available for operating positions.

In some cases, management has been unable to negotiate changes in the traditional way ability and seniority are balanced. An appliance plant's procedures are typical of facilities where management introduced only modest changes. The managers classified the new, multiskilled operator position above other jobs—in part to minimize bumping during layoffs—but they instituted no new selection procedures. Accordingly, they encountered problems when the new pay rate for this job attracted 50 bids for the first 6 positions—many from applicants who lacked the basic verbal and quantitative skills to absorb the training. The labor contract mandated training for the senior employees who bid on the job, however, so management's only screening option was to spell out the job's multiple duties and encourage self-selection. Although about half the applicants withdrew, the managers realized that in the future they would need to negotiate a change in the selection process so that the most proficient operators would have a chance at the training.

The NRC study found more innovative selection processes in other unionized plants. At an axle plant, for example, applicants for skilled jobs completed an eight-hour assessment of their technical and interpersonal skills, conducted by a local community college. They were given a four- to six-hour skill-level inventory, which included simulated problem-solving exercises, and then attended a family night with their spouses to discuss the program. The 45 applicants who remained from an initial group of 100 were then ranked by seniority. Some of them declined the new jobs; 16 were eventually placed. Many dropped out because working in the new plant involved shift work or demanded higher performance standards than they were prepared to accept. Others declined because they felt unqualified or had only a few years to go before retirement and did not want to waste the company's investment.

A unionized diesel engine plant devised a multistep process in which the 250 initial applicants were divided into small groups and given a four-hour briefing on the technology and the new job's duties and expectations. Those who persisted were interviewed by a committee of two manufacturing supervisors and two union representatives. The union representatives went out of their way to warn applicants how different the new operation would be and cautioned them to reflect on their interests and aptitudes. Taking the interview results into account, as well as attendance records, seniority, experience, and any evaluation records, the same committee made the final selection.

The general point is that managements and unions can devise ways to consider criteria other than seniority without losing workers' confidence in the fairness of the selection process.

Another juncture for these creative arrangements arises when work-force reductions are required. At an auto plant with a CIM system the parties worked out a procedure whereby senior workers could not bump CIM system operators, but would "back fill" positions vacated by individuals who were on a "qualifiable" list—in turn the latter moved into the unit to displace the junior people who would then be placed on layoff.

The unions involved pursued these innovations because union officials, as much as their counterparts in management, appreciated the importance of selecting people who would be able to perform well. They understood that the effectiveness of the new technology—and thus the plant's competitiveness—would depend on the performance of the operators. And they were concerned about wasting money training the wrong people.

Supervisors' predispositions can be as much a constraint on the effective utilization of certain technologies as the union contract. We have emphasized the importance of a set of organizational ideals to guide technology development. However, even if the system is designed to be managed in a prescribed way, there is no guarantee the managers actually in charge of the system will manage in the intended spirit. An aspect of the organization that is especially susceptible to differing managerial predispositions is the approach to performance management.

In a case involving a decision support system for paper machine operators, which gave them the cost information and process expertise they needed to operate with more autonomy, supervisors of the operators felt threatened by their loss of relative power and began to use the monitoring capacity of the system to tighten their supervisory control (Bronsema and Zuboff, 1984).

A study of the Internal Revenue Service's (IRS) implementation of its Automated Collection System (ACS) by Chalykoff (1988) found that supervisors differed in terms of their use of the computer-aided-monitoring feature of the ACS. This feature enabled supervisors to monitor an employee's terminal work and phone interactions with taxpayers. Some supervisors tended to use this capacity in ways that developed employees, while others used it in ways that made employees feel controlled and subjugated. These patterns reflected the dispositions of supervisors, dispositions that would be influential even if the ACS planners had been more prescriptive about how the monitoring capacity was to be used.

In another technology introduction at IRS—the issuance of lap-top computers to 14,000 examiners—the Treasury Workers' Union insisted on an agreement that use or lack of use of the new PCs could not be considered in performance appraisals. While such a policy was understandable given the union's concerns that supervisors might exert undue pressure on the examiners to use the new tool, such a restriction is certainly untenable for the long run and illustrates a generally adversarial relationship and lack of involvement by the union in the early phases of decision making regarding new technology.

Thus the paper mill and IRS cases underscore the need for implementation methods that include efforts to enlist the support of all stakeholders.

Conclusion

In this paper we have outlined an approach to the introduction of new technology that combines mutual commitment regarding the design of the employment relationship with a collaborative labor-management relationship (if a union is present). The elements of this approach to mutual influence that include employment security, training, constructive climate, and extensive participation apply equally well to the challenge of implementing change in a nonunion setting.

The alternative and more traditional compliance/adversarial approach may produce results sooner, but the scope of the change is limited and the organization does not develop any capacity to adjust in the future. Indeed, subsequent introductions of technology will require another round of push and control by management.

A shift to the mutual influence model starts with a recognition by the parties that there must be a better way of introducing technology and conducting their affairs. It is our experience that most employees are more than ready to embrace such an approach. Even unions which historically may have opposed new technology and adhered to an adversarial orientation are much more willing to engage in cooperative endeavors as long as there are benefits in terms of employment security and greater involvement.

Thus, the current scene presents many opportunities for introducing new technology concomitantly with an improvement in employee and union relations.

The current scene presents many opportunities for introducing new technology via constructive labor relations. It was only several decades ago that a number of unions actively *opposed* new technology or at best sought to *control* its introduction with various work rules and crew size requirements. Today, such actions by unions are much more the exception.

Some relationships remain locked in an adversarial mode that prevents the realization of the full benefits of new technology, but this is due as much to habit or mangement's desire for an arm's length relationship as to union policy.

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Discussion

A highly charged issue in adopting new technologies concerns the testing and screening of employees to determine their qualifications for operating the new equipment. This often is especially important in the adoption of computer-based manufacturing and office automation technologies because of the fact that, as Paul Osterman's paper noted, the skills required to operate these technologies differ from those associated with older process technologies. Morton Bahr raised the testing issue, noting that many workers, especially older workers, are extremely anxious about their ability to pass tests and thereby retain their positions within firms adopting new technologies. He argued that testing has not been employed in a logical or consistent manner by many firms. For instance, many workers who have been out of school for a number of years find it difficult to pass formal written tests without some preparation. At one AT&T installation, Bahr reported, employees with as many as 25 years of experience who couldn't pass a written test were being laid off at the same time that new workers were being hired who had little or no loyalty to the firm and no demonstrated discipline or familiarity with the overall production process. More recently, however, a number of the Bell operating companies have developed policies to help workers prepare for diagnostic skills tests:

> **Just a few weeks ago, we worked out with Bell South a 15-month program where each worker who is so affected will have a coach. . . . I don't believe there is going to be a problem with anybody not being able to move into the new work in the entire Bell South Company. . . .**

William Burrus (Executive Vice President, American Postal Workers Union) argued that the Postal Workers, like most other unions, have supported the introduction of new technology, in contrast to the widespread perception that unions oppose new technology in the workplace. Burrus argued, however, that many unions find it difficult to deal with the consequences of new technologies when they are brought into the decisionmaking and implementation processes very late in the game:

> **. . . we are brought in way downstream. . . . And when we are brought in at that stage, there is automatic resistance, not the type of resistance that occurred in this country in the '20s and '30s, but the resistance of the '80s that you are not involving the working people, the people who are forced to work that equipment.**

Another recurrent issue in technology adoption within the unionized workplace concerns the relationship among the union, management, and individual workers. For instance, worker participation in such cooperative efforts as Quality of Work Life (QWL) and Employee Involvement (EI) programs may involve direct communication between management and the worker, outside the union's jurisdiction. Is this a threat to the union? This question was raised by William Burrus, who noted that his union had not involved itself in QWL and EI programs in order to avoid being bypassed:

> **. . . until the English language provides us with more descriptive words for our relationship, we are left with the term adversarial. . . . We believe that very basically from the employer's standpoint it [EI and QWL programs] is an attempt to establish a relationship between the employer and the employee directly, hoping that in the long run it will eliminate the employees' view of the union itself, and perhaps in the next generation or three generations down the road, they will find that it is no longer necessary for them to have an intermediary to speak for them. . . .**

Morton Bahr described the origins of QWL/EI programs in the Bell System (as it was then known) after 1980, noting that "I was one of the skeptics in 1980," and discussed tactics for introducing such programs:

> **. . . where you try to put a QWL process in a location where the union is weak, you are going to lose the union in the location. . . . So you select the participants in the process, and we make sure that where we put it in the local union is strong, that there is a knowledgeable shop steward who is on that committee and that the matters that are reserved for collective bargaining are not discussed. . . . And our experience now, some 8 years later, has been largely positive, not 100 percent. There are a number of failures, but I am now persuaded that this is the road that we have to follow.**

Joseph Mahon noted in reaction to Burrus's comments that many of the employee involvement activities of the Postal Service are responses to employee desires, rather than attempts to bypass union representatives:

> **What we do like, and what we think the employees want, is [to have] them talk to us, and they will do it, whether a process is created or not. We can see it. The new values of the present work force are much different than they were 20 years ago. Our research, our observation tell us that people, no matter what union they are in, no matter what bargaining unit they are in, want to have a say-so on where the company goes and what their job is composed of. . . .**

Taking up a question first posed by Robert Zager and subsequently by Robert McKersie in his presentation, John Read suggested that one reason for the slow diffusion of "best practice" techniques of labor-management cooperation is the failure of managers and, in some cases, local union leaders to develop a plan for employee involvement that is well-tailored to the requirements of a specific workplace:

> **. . . we sometimes launch a concept out over the work force or over the local situation and expect a concept to be implemented rather than . . . going to the situation and taking the concept and breaking it down into its parts so that what you have is something that is digestible and understandable. . . .**
>
> **We do too much exhorting of the parties into a vision or a concept and not enough implementation-oriented [work] . . . if we did more of that, I think the pace [of adoption] would quicken. . . .**

The group considered whether technology is diffused more rapidly in union than in nonunion environments. Lynn Williams argued that technological change and innovation in work force management are more likely to occur where there is a union:

> **The worker . . . can approach . . . the participatory model with a much greater sense of security about his or her own position, whereas in the nonunion environment, no matter . . . how much participation is encouraged there remains in it an element of paternalism, an element of company power to do something, whatever that may be, to the person. It is impossible, I think . . . in a nonunion atmosphere to go all the way in terms of participation.**

Walter Blake (Vice President, Labor Relations, Kroger Company) commented that his company had acquired a number of nonunion facilities in recent years, and found that QWL and employee involvement programs were easier to institute in the union workplace:

> **Where we have a very active union leadership in our stores, . . . it works best. The employees of the store and the management of the store really start working on business problems related to the customer and serving the customer better and more effectively, and where we have either weaker [union] leadership . . . or none . . . we [are] not successful.**

In response to Blake's comments, Lynn Williams and Morton Bahr both noted that in unionized workplaces with successful employee involvement programs, the union has an opportunity to become involved in a much wider range of issues that influence the quality of worklife. Williams argued that ". . . instead of working on the fringe fighting arbitration cases . . . all the time, we are involved with the mainstream of the interests of our members." Blake, Williams, and Bahr agreed that in unionized workplaces with effective employee involvement or QWL programs, grievances, arbitration cases, and the use of other formal channels for resolving worker-management conflict drop, reflecting the fact that more effective alternatives to these mechanisms exist.

Larry McKean described Boeing's experience with employee involvement in the introduction of new technologies. A number of union-management committees were established on an experimental basis early in the decisionmaking process to discuss the introduction of new technologies in different production plants. Based on the success of these experiments, a joint committee was established recently to work on the design of a new production plant in the Seattle area:

> **One year before we broke ground and we got the facilities money, we sat down with . . . two of our major unions that will be involved and said, 'Here is where we think we are going to build a new building, and we would like to look at automation, cut down flow time and . . . [minimize] inventory, [expand] employee involvement, and let us work together on it'. . . .**
>
> **. . . how do we address job security? We did it on a handshake. We are not going to lay anybody off. We are going to retrain the people who would like to go, and see if they don't fit into this new facility. . . .**

> **. . . we took 250 people, hourly, salaried, some managers, engineers, and off site employees and said, 'If you had a chance to build this building, this facility, your workplace, how would you do that?'. . . Benefits were not brought up [by the employees]. It was actually how they would like to see their work designed, how they would like to see this operation proceed, and it went very, very well. And the union folks have been able to talk about it in their newspapers and their writings, and we have done the same thing.**

John Read suggested that, whether or not there is a union, the essential ingredient for cooperative employee-management relations is leadership. Although a union can bring worker leadership to the fore, he contended, it is only one means to develop such leadership. Other situations also can create support for teamwork that facilitates cooperation between workers and management.

Robert McKersie agreed that in many industries, unionized plants are at least as receptive to new technologies and management practices as are nonunion establishments. He ascribed this to the tendency for unions to be stronger in mature industries that face severe competitive pressures. Union representation is associated with, but need not be a cause of, innovation. He argued that innovations are often initiated in the nonunion sector and then accepted out of necessity by unions.

Robert Zager concurred with John Read that nonunion companies can be as innovative in work force management practices as unionized workplaces, but argued that this was likely only in firms that have a history of delegating authority to the workers:

> **But in most companies where management prerogative is the be-all and end-all, it is almost impossible to have a long-lasting cooperative relationship unless there is a strong union, and the reason for that is quite simple. What you are asking people on the shop floor to do is bubble up fresh ideas. Every time they do that, they attack the authority of supervisors and middle management, and the only way to break through that—it is a perfectly natural resistance— . . . is with the countervailing strength [of a union].**

Echoing an earlier comment by Lynn Williams, Morton Bahr noted that most union-sanctioned employee involvement agreements specify that any productivity gains must not result in anybody losing his job. This provision strengthens the incentive of workers to participate in these programs and, in his view, facilitates the introduction of innovative work force management practices in unionized workplaces.

New Technology and Continuous Learning

A Paper Prepared by

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In leading-edge, highly competitive companies, training for new technology has moved from the periphery toward the center of managerial concern. Gradually, training—or, more accurately, organized learning—is becoming an integral and continuing part of every job. This, in turn, requires employers to provide a reasonable measure of employment security, as a means of protecting their investment in people. It also compels them to manage organized learning as productively as possible.

This pervasive training has spurred—and has served as a vehicle for—increased cooperation between management and the work force. And where employees are represented, it has stimulated managements and unions to find new ways of helping each other, without diminishing either side's vigor in the pursuit of separate interests in collective bargaining.

The most common occasion for training for new technology is when the employer wants to prepare employees to implement a particular piece of hardware or software. Implementation, however, goes far beyond "operation" in the usual sense. In order to use a piece of technology profitably, an organization must do much more than operate it; it must also design for it, power it, load and unload it (with information as well as physical material), adjust it, repair it, maintain it, improve it, and adapt it to new uses. In addition, the piece of new technology may have to be coordinated with other pieces of new or existing technology. Each of these functions is at least as difficult, technically, as operating and calls for its own set of skills and knowledge.

The decision to adopt new technology carries with it the demand for new skills and knowledge, but it does not determine which individuals shall acquire which skills and knowledge. If the employer asks employees simply to follow instructions and to ask for help when something goes wrong, management will give them a bare minimum of training but make sure that higher-level professionals and managers know enough to fill the gap. On the other hand, if the employer expects all employees to take responsibility for continuous improvement of quality and productivity, management will encourage and help their workers to learn as much about the new technology as they can.

Companies that compete on the basis of quality of product or service have been most assiduous in ensuring that new skills and knowledge permeate the organization. Rigorous inspection, removal of faults, and correction of fault-creating conditions must take place at every stage. Although the employer could, in theory, make these things happen by multiplying the number of quality inspectors and controllers, the cost and confusion would be fearsome. The alternative, which has been adopted with great success, has been to give workers the knowledge, skills, and opportunity to do it themselves. Similar considerations affect the repair and maintenance of new technology. The training consequences of electing to "smarten-up" the workers instead of "dumbing-down" the work stand out most starkly in the case of computer-integrated manufacturing systems.

Implementation is not the only or most important occasion. Training is also essential when the organization has to decide *what* new products and services to produce, *how* to produce the new products and services, or *which* new processing technology to select. Although training for these purposes is usually provided only to higher-level professionals and managers, a few companies have included ordinary workers, too, with remarkable results.

Toward Continuous Learning

The new conditions of the global marketplace are pushing major employers toward continuous learning. Continuous because internal and external needs change so rapidly, and because employers are realizing that if higher quality and productivity are the goals, *everyone* in the organization has to be brought into the act. Learning, rather than training, because learning puts the emphasis on the end—i.e., acquisition of knowledge and skills—whereas training puts the emphasis on the means—i.e., how someone gets someone else to acquire knowledge and skills; and because learning implies that the learner is an active partner in the process, not merely an empty vessel into which knowledge is poured.

While individual companies practice one or more pieces of the continuous learning model, none known to us has adopted it completely. The essentials are these:

- Learning is an everyday part of every job. The line between job performance and learning disappears.
- Employees, in addition to mastering the skills specific to their immediate tasks, are required to learn the skills of others in their work unit. They are also required to understand the relationship between their work unit and the organization as a whole, and to be familiar with the operation and goals of the business.
- Free-form interaction among employees, teams, trainers, and managers is encouraged and institutionalized.
- Employees are required to transmit their job knowledge to, as well as learn from, coworkers.

Continuous learning can be sustained only if it is institutionalized in appropriate structures and mechanisms. For example, professionals and managers may negotiate training goals with their bosses, as part of *management by objectives* (MBO) or in connection with a periodic performance appraisal. In *train-the-trainer* programs, "content experts" in the organization gain the skills to deliver, and sometimes also to design, courses which would otherwise require professional trainers. In *continuous learning centers*, employees voluntarily teach and learn from one another more productive ways of using a particular technology to which all are assigned. Members of *semiautonomous work teams*, as a regular part of the job, train and are trained by one another. A different sort of institutionalization occurs when an employer and its unions jointly administer all or part of the training process, such as needs analysis, course design, instruction, evaluation, and funding.

It is highly advantageous that trainees should be involved (directly or through chosen representatives) in every aspect of designing and delivering training programs. Not only managerial employees but ordinary workers have much to contribute. Taking part in needs analysis gives them a chance to apply their knowledge and to become familiar with the technology they are to learn. They know which skills they possess and which ones they do not, and this ensures that the training will not be redundant. Taking part in the selection, design, inspection, and assembly of the new technology itself gives them invaluable insights and allows them to bring workplace realities to the attention of the engineers while changes can still be made. Designing the content and method of a program is a form of training, and it helps ensure that the program will match the trainees' state of knowledge. Serving as trainers has similar effects.

Our cases report employees of every level taking part in activities of all of these kinds, to the benefit of the employer and themselves. Professional trainers maximize their own contribution by providing advice and support as the trainees request it.

Learning by Objectives

Companies in high-tech businesses have evolved a variant of management by objectives as the vehicle for involving technical, professional, and managerial employees in the analysis of their own training and development needs. Usually as part of a formal MBO system, manager and employee sit down together and negotiate a written agreement on the technical and professional training the subordinate will undertake in the coming six months or year. At the end of the period they review the outcome and decide what further training is called for. Both understand that the subordinate's career will be shaped by these decisions.

In 1984, a division of Xerox linked training to its system of performance feedback and development (PF&D). The system requires that each employee and his or her manager jointly write down the performance and learning objectives the employee is to reach over the coming year. At the end of the year, they jointly measure accomplishments

against objectives, and a summary of the findings goes into the employee's permanent record. Employee and manager meet at least once during the year to review progress and, if necessary, revise objectives. Although training is not "compulsory," 40 to 50 percent of the employees enroll in courses or workshops each year.

Train the Trainer

If learning is to be truly continuous, the organization must look to its own resources for much of the teaching. Exclusive reliance on professional trainers, whether internal or external, is expensive and often redundant. Leading companies have therefore been teaching all sorts of employees the art of training, which content experts can learn more readily than training experts can learn unfamiliar technical content. As a bonus, the ad hoc trainers reinforce their own knowledge.

At Joy Manufacturing Company, it became necessary to consolidate three overlapping and sometimes competing marketing units into a single regional structure and to add the support functions of manufacturing and warehousing to each part. Line managers, most of them at levels above the regional, were invited to instruct in their special skills. First the invitees passed a train-the-trainer program, consisting of: (1) an introduction to designing competency-based units of instruction, and (2) basic presentation of skills. Each manager drafted the course materials he or she would use, in the form of written units or modules. Each manager was filmed by a video camera as he or she presented part of the proposed course to the other managers; then the manager watched the replay, listened to the comments of the audience, and presented a revised version. In the judgment of the external consultant, about two-thirds of the instructors attained professional training proficiency within a year.

At General Foods' multiproduct plant in Dover, Delaware, management and the United Food and Commercial Workers (UFCW) carry out training jointly. When a new training manual is needed, the department manager selects a team of employees and managers representing the affected areas or functions; operators, supervisors, professionals, and managers may take part. The team spends three days in learning-task analysis, and two days in train-the-trainer sessions.

Continuous Learning Centers

In a continuous learning center (CLC) employees who operate similar equipment come together to learn from one another how to extract higher performance from the equipment. They do not share responsibility for output, although they may on occasion help one another out. Management initiates the center, offers guidance and support, and provides the time and place for meetings. Employees take part on a strictly voluntary basis, on company time.

One division of Intel established a CLC to help secretaries learn to use and adapt their new personal computers. A representative council—secretaries who had participated for years in department decisions—served as directors. Instead of signing up for one course at a time, secretaries became "members" committed to attend classes and share knowledge with others; the organization committed itself to help individual development. To encourage participation, members were publicly identified as such. Feedback took place through surveys and evaluations of CLC services. Managers constantly communicated with members about adaptations developed in other parts of the organization and about the importance of experimenting and sharing ideas.

A CLC in another division, designed to support employees at all levels in learning to use and adapt PCs, began by helping secretaries install their equipment and deal with problems of reliability. Those who developed interesting new uses demonstrated them before large groups. Those who ran into trouble could call a hotline for immediate help.

Work Teams and Pay for Knowledge

In the past decade many factories and offices have adopted the work-team form of organization. A work team is a small, permanent group of employees who combine their different work assignments to produce a shared output: a product, a service, or a component. Related skills may be integrated into a team member's job; for example, machinists might be trained to perform not only set-up and operating tasks but also quality inspection and minor maintenance. Managerial as well as operating responsibilities may be included.

Central to the concept is that each job should contain a reasonable amount of variety and self-direction, and that each employee should have the opportunity to learn and to add responsibilities. At a minimum, each member learns some of the tasks of other members. This enables members to rotate jobs and function in emergencies. It also implies a heavy dose of continuous learning and flexibility in work design.

In a growing number of companies, team members receive a wage increment for each new skill they master ("pay for knowledge"), whether or not the new skill is actually applied on the job. The concept appears to have been carried to extremes by Johnsonville Sausage Co., of Sheboygan, Wisconsin. Tom Peters reports that:

> "The typical Johnsonville work team does its recruiting, hiring, evaluation, and firing; regularly acquires new skills and conducts its own training; formulates and tracks its budget; makes capital-investment proposals as needed; handles all quality control, inspection, and subsequent troubleshooting and problem solving; suggests and develops prototypes of possible products or packaging; works on improving everything, all the time; and develops quantitative standards for productivity, quality, and improvement. . . .
>
> "All raises are based on merit, and most are tied to additional education and demonstrated new skills. It's an extra 20 or 50 cents an hour if you take on leadership of the team's budgeting effort, an extra 25 cents if you take an outside course to become a trainer and then take over leadership of your team's training activities, and so on. . . .
>
> "All workers take a sophisticated course in economics. But, more important, they are encouraged, with company support, to study anything, job related or not." (*Chicago Tribune*, June 20, 1988.)

Unions and Continuous Learning

A unionized workplace can follow a policy of continuous learning only if the union is involved. Widespread participation by employees in many stages of the training process, including the transmission of their own skills to others, inevitably touches job descriptions, work rules, and other collective bargaining issues.

Union involvement in continuous learning is most effective when the parties act jointly in planning, design, and direction of learning programs at national, regional, and plant levels, when unions and workers jointly conduct needs analysis, decide course-content and share the responsibility for results, and when they jointly administer funds that finance training programs and assure long-term commitment to goals and objectives.

In Ford Motor Co. plants undergoing a major changeover, a corporate group often takes charge of installation and training. At Ford's truck transmission plant at Sharonville, Ohio, which is converting to manufacture a sophisticated new four-speed, electronically controlled automatic truck transmission, employee involvement has become a way of life; so the Launch Training Team, formed in 1986 and consisting of seven salaried and five hourly employees from the plant, is responsible for all training in connection with the changeover.

The Launch Training Team has shaped training to accommodate the Natural Work Team form of organization on the shop floor. All members of Natural Work Teams are classified as manufacturing technicians (MT), receive pay-for-knowledge, and agree to share skills and information. The Launch Team has designed two curricula for MTs: an 80-hour course in non-vendor-specific machine skills and a 40-hour course in group-working skills. Methods include stand-up teaching, hands-on learning, and interactive video. The actual training of MTs in machine skills is conducted by any hourly worker considered expert on a particular subject.

For equipment-specific training, members of the Launch Training Team visit the vendor's plant, write training objectives for the equipment, and designate skilled tradespeople and MTs to specialize on it. The specialists go to the vendor's plant for extensive training and then train their fellow employees to meet the objectives set by the Team. Attainment of objectives is tested by means of procedures designed by the Team, often using equipment built by members of the Team.

Jointly administered training funds, such as those in the Big Three auto companies and some of the telephone companies, dramatically illustrate the argument that training is a continuing need, regardless of economic fluctuations, and that training is linked to employment security financed by company prosperity. Since millions of dollars are diverted from the wage-benefit package into these training funds, employees have a visible stake in the fund and a measure of control over the contents and form of training.

The fund gives the parties more opportunities to talk out the nature and timing of technological changes long before the changes take place. Since most companies ignore the impacts of change on the organization and individuals until it is too late to plan for them, this may prove to be the greatest advantage of all.

Continuous Learning and Employment Security

Continuous learning thrives best in an atmosphere of employment security, because employment security stimulates employees to give their best efforts under conditions of continuous change. Employment security need not mean a "no-layoff" policy, which is risky in the extreme. Workers are realistic about an employer's ability to shield them from the winds of economic change. They consider it fair that they should suffer hardship when an employer is really in trouble, provided that the rest of the organization shares equitably, but may resent a situation in which the employer makes a profit by displacing people through productivity improvements and technological changes. What employees want are assurances that layoffs or dismissals will be used only when sacrifices are truly essential, and that, in case of dismissal, the employer will strive to help them get suitable jobs elsewhere.

A promise of employment security has to be delivered as cost effectively as possible. Work in America's 1984 report, *Employment Security in a Free Economy,* describes a score of strategies for coping with frequently encountered problems such as: keeping work force levels permanently matched to demand, using employees profitably during a temporary business decline, reducing costs without dismissals during a permanent decline, and helping employees make the transitions to new jobs when dismissals become unavoidable.

One key strategy entails moving employees out of jobs that have lost their value to the employer and into jobs that are more valuable. In today's conditions, such a move normally entails additional knowledge and skills, and sometimes a whole new occupation. The organization, therefore, needs to know in advance which jobs are on the way out and which are on the rise; what skills and knowledge the new jobs will require; which employees will be available to learn and fill the new jobs; and what additional training they will need.

Most employers take for granted that it is cheaper and easier to fire employees with obsolescent skills and replace them with already-trained outsiders than to retrain existing employees to handle new technology. The fact is, no one can say confidently which option, as a general proposition, is less costly in strict accounting terms. Each situation has a different answer. Typically, employers underestimate the ability of employees to learn new skills, as well as the true dollar costs of firing (e.g., severance, unemployment compensation, bumping) and hiring (a six-month learning curve for new employees). They overestimate the costs of retraining.

In late 1982 and early 1983, Xerox required skilled professionals in computer engineering, electronic engineering, and computer science, skills for which the market was tight. At the same time, need for the skills of many of its current professionals—experienced engineers, chemists, physicists, and others—was diminishing. With the aid of Rochester Institute of Technology, more than 40 professionals with redundant skills were given new, necessary skills.

An intensive program took the first set of retrainees through 17 courses in 9 months, with 16 hours of class per quarter. The graduates received high praise from the managers who received them, but the intensity of curriculum caused 11 of the 29 retrainees to drop out of the program. In the two subsequent iterations of the program, dropouts were reduced by spreading the curriculum over an extra three months and by providing pre-entry refresher courses in math.

Xerox has found the program in line with the costs of available alternatives. To relocate a professional/technical employee in such a far-flung company can be very expensive. To dismiss one is also costly, since the company allows a redundant employee six months at full pay to find another job, plus severance pay and benefits. Moreover, it must be borne in mind that hiring a new employee with the needed skills is also costly: it takes six months for one to become fully productive.

Pacific Northwest Bell has a Job Skills Bank to deal with redeployments in all sectors of management. The basic concept is simple:

- **Each management employee who wishes to enter the Bank fills out, with the help of a handbook, a detailed profile of skills, experiences, and preferences. The profile goes into the computer and is updated annually.**
- **When a management job opens, the personnel administrator must submit a job vacancy form, filled out according to the same handbook codes.**
- **The Bank's computer notifies registered employees (and their supervisors) of all job vacancies for which they appear to be qualified.**
- **If an employee is interested in a vacancy, he or she must discuss it with the employee's current supervisor. Only the supervisor may nominate the employee for the vacancy. However, personnel administrators of the departments with vacancies are also notified which employees are available to fill the vacancies.**

According to PNB, the success of the bank requires two conditions:

1. **Precise coding of skills both in the applicant's profile and in the vacancy notice.**
2. **Cooperation on the part of the applicant's supervisor.**

Pacific Bell (which since divestiture in 1984, has reduced its hourly work force by 20,000, with only 500 actual layoffs) and the Communications Workers of America (CWA) have established joint mechanisms for training and retraining in support of a policy of employment security. A Training Advisory Board (TAB), comprising four union and three company representatives, advises on curricula and courses, evaluates programs, and encourages employees to participate.

To assess training needs, the TAB draws on two sources of information:

1. **Technological change reports, issued quarterly by the company. These reports forecast new systems and technological changes, their expected impact on the work force, and the projected beginning and completion dates of each change.**
2. **Reports from local common interest forums. In each major geographical area of California, a joint forum, headed by the company's local vice president and the local union president, meets regularly to discuss possible force reductions and how to cope with them and transmits its findings to the TAB.**

Workers are kept up to date on declining and rising job opportunities, and training is provided for those who volunteer to move. A weekly updated program shows employees the availability of jobs by geographic area, department, title, salary, and so on; uptrends and downtrends are forecast for each management group. Employees have access to information about career planning, job exploration, and the workings of the company's transfer and upgrade plan. Customized computer programs help employees to determine skill requirements for specific jobs and to assess their aptitudes for those skills; individual career counseling will be available. When the company identifies an area of job growth, it works with community colleges and the CWA to develop curricula for pretraining courses. The names of those who complete the courses go into the file, ready when the time comes. Employees can take virtually all off-the-job training at no cost, but on their own time. Those interested in jobs outside the company receive outplacement services.

Context Learning

In order to maximize the success rate in retraining employees for new occupations within the firm, employers are paying closer attention to what may be called context learning. Knowledge and skills related to the operating processes of the work unit are essential, but employees must also understand in some detail how the work unit actually operates, its objectives, the kinds of problems that arise, how people in the unit share responsibility, where to turn for help, what sort of performance the supervisor expects of employees, and how the unit interacts with other parts of the firm (especially its internal customers).

Normally such things are learned on the job, after the employee joins the work unit. However, when a significant proportion of retraining consists of classroom or other off-the-job instruction and this takes place before joining the work unit (which is the usual case), the effectiveness of retraining may be seriously impaired.

Hewlett-Packard finds that it needs fewer people to manufacture and assemble products and more people to fill the increasingly sophisticated technological jobs in the office. Since HP does not lay off except as a last resort (only two instances since 1939), it has chosen to deal with the growing job mismatch through retraining.

A pilot program for divisions in the San Francisco Bay Area began in June 1986. A core set of skills was designed to fill jobs in the six categories of greatest demand: electronic data processing support, computer operator, administrative support, telemarketing operator, secretary, and field and factory order processing support. The 35 pilot trainees received core training in math, English, typing, office procedures, time management, and introduction to computers, over a period of three months. By September 1986, most retrainees had been placed in their new positions, with enthusiastic feedback from hiring supervisors and department managers.

The program combined academic and on-the-job training. A mentor with direct knowledge of the chosen field provided each trainee information and relevant on-the-job training experiences.

Upon acceptance, candidates and company signed an agreement outlining responsibili-

ties. The trainee agrees to complete on-the-job training assigned by the career mentor and to keep supervisors and program coordinators informed about the trainee's progress. The trainee's current supervisor agrees to adjust work schedules and responsibilities so as to facilitate retraining and job placement. The hiring supervisor agrees to give the trainee detailed information about what the job entails and to work with the trainee's career mentor to get the most out of on-the-job training. The program coordinators of the sending and hiring units agree to oversee the program, work closely with the supervisors and career mentors, and discuss training progress with the trainee.

Trainees were told about the community college system, effective learning and study techniques, test taking, career planning, and interpersonal relations. They toured the community college and met instructors and other college officials.

According to HP, training worked best for those who were placed in their new jobs early in the program. They quickly became familiar with the new work environment and thus were able to grasp the relevance of the training.

Cost-Effective Design and Delivery of Programs

As companies put more resources into training and retraining, their concern about the cost-effectiveness of that expenditure grows. The concept of cost-effectiveness arises in two quite different contexts. The first involves deciding whether to spend money on training as against other forms of investment (e.g., land, buildings, equipment, additional staff). In the current state of the art such an application of the concept does not persuade decision makers one way or the other.

How much should an employer spend on training (e.g., as a percent of revenues)? At present there are no useful answers. Employers and professional trainers have yet to agree on how to *measure* the costs of training. For another thing, company figures range all over the lot, from 9.5 percent of revenues down to 0.2 percent. Third, a company's expenditures on training depend on the type of industry, the company's size and prosperity, its personnel policies and practices, and so on, which makes inter-company comparisons tenuous, at best. Finally, the question assumes that all training is uniformly efficient, that value is commensurate with cost, and that the need for training is infinite. These assumptions are clearly unwarranted. A more useful question for employers is, How much must the company spend on training in order to acquire, as economically as possible, the skills necessitated by corporate strategy?

The second kind of decision involves choosing between one training program and another as alternative routes to essential training objectives. Today the realistic choice is not just between programs A and B, but among A,B,C,D, and so on. This application of the cost-effectiveness concept is both feasible and necessary, even though each company must devise its own formula.

Very few companies evaluate training systematically. Evaluation should take place before and after a program is carried out. When a program is proposed, higher management should gauge its probable effectiveness against the following criteria:

- Are the objectives (people to be trained, skills to be acquired) necessitated by corporate strategy?
- Is the content of the program sufficient to achieve the objectives?
- Is it only what is necessary for the purpose?
- Does the program make correct assumptions about the current knowledge of the trainees?
- Does the program make use of the best available delivery systems?
- Does the program make the best use of the chosen system?
- Do program design and delivery take account of the latest knowledge about how adults learn?
- Is documentation of the program sufficient to ensure its maintenance and quality control?
- Does the program provide for measurement, evaluation and validation from the beginning?
- How much will the program and delivery system cost?
- Is the delivery system easy to use? Is it readily available when the trainee is ready? Can it be used under varied conditions?
- Will the program, as delivered, hold the students' attention?
- How rapidly can the trainees reach the skill objectives with this program and delivery system, as compared with the alternatives?

After the program has been completed, the employer should ask: Were the skill objectives valid in terms of corporate strategy? How fully were the objectives attained? Was the training performed within budget?

Who should evaluate how well the program has achieved its skill objectives? In principle, those on whose behalf the training was performed—the trainees, the manager, and higher management. The trainees can judge whether they enjoyed the training and whether they feel they learned something useful. But the manager (especially if costs are charged to his budget) is the one most directly concerned with whether trainees have actually acquired the promised skills. On the other hand, the validity of the objectives can be determined only by those who set corporate strategy. Supervisors may know what they want to gain through training, but their ideas do not necessarily reflect corporate strategy.

Cost and effectiveness are closely entwined in the design and delivery of training. The more sophisticated the design and the delivery system (e.g., classroom, computer-based, or interactive TV training), the greater the "up-front" costs. On the other hand, some of the most effective delivery systems enable learning to take place *at the work site,* with minimal time away from the desk or shop. Since students' travel and lodging raise the price of training programs—indeed often far exceed the cost of design and delivery for a major program—the more expensive model may be more cost-effective.

IBM's systems approach to training has five key ingredients: (1) detailed curriculum design, based on defined business requirements, (2) instructional design for each course, (3) course development led by interdisciplinary professional teams, (4) delivery through the most advanced techniques available, and (5) measurement and evaluation at every stage.

New delivery methods have widened the range of choices but have also made course design, development, and delivery too complex for a single instructor. A team of highly trained specialists is needed.

Delivery is the key to cost-effectiveness. The push to decentralize through on-site video-computer systems or interactive TV is relatively recent at IBM; 75 to 80 percent of all IBM training is via the traditional classroom. But within the next ten years, half of IBM training will be delivered by "student-driven" learning-center based methods (e.g., computer-based training, instructional TV with personal computer or other self-study methods using workbooks or videos). IBM sees a potential for off-loading 50 to 75 percent of all student days. The main advantage of off-loading is shown by IBM's rule-of-thumb calculations as to how much alternative delivery systems cost:

- **$50 a day for on-site self-study, computer-based training or interactive videodiscs.**
- **$150 a day for classroom education within commuting distance from home (includes cost of education facilities, instructors, administrators, and managers).**
- **$300 a day for classroom education at a central education center (includes the cost of travel to and from airports, plane fare, the cost of hotel, and meals).**

Cost-effectiveness is not limited to computer-driven methods. Instructional TV, for example, as provided by National Technological University, combines traditional classroom instruction design with the latest in satellite broadcasting, to help young B.S. engineers obtain master's degrees through part-time participation in selected disciplines (bearing in mind that only 30 percent of B.S. graduates currently stay on for advanced degrees). It also helps older professionals learn the most advanced technology concepts from leading authorities, on a non-credit basis.

Eventually, every NTU instructor will be able to teach on-and off-campus students simultaneously, enabling part-time students at their job sites to view the class live and, through telephone linkages, ask questions during the class session. Demonstrations of this interaction through teleconferencing via satellite have been successful. Since NTU classes are designed to serve about 55 off-campus students on average, classroom interaction between teacher and off-campus students can be easily accommodated.

Another cost-effective device for delivering large-scale training programs is the consortium of community colleges. When large numbers of employees are geographically dispersed and need classroom courses with a consistent standard of quality, no single institution can do the job. Several ad hoc and permanent consortia have been formed.

GM's Automotive Services Educational Program (ASEP) has enlisted some 40 colleges all over the U.S. to provide up-to-the-minute training for technicians who will service General Motors automotive products, especially in dealers' repair shops. (Ultimately there will be 50, putting ASEP within reach of every GM dealer in the U.S.) The colleges provide faculty, curriculum, classrooms, and administration. GM provides equipment and

> **materials (including new cars, shop manuals, parts, and so on), plus free training for the faculty. The course consists of two years of rotating education and training, leading to an Associate of Arts degree. The college provides classroom training; the dealer provides on-the-job training.**

Lastly, I should like to mention an ingenious new instruction design for the cost-effective training of people who are literate, but only inadequately so. According to employers, a large proportion of young adults, and some mature workers, cannot be trained for new technology because they lack the basic skills—reading, writing, listening, comprehension, math. Since employers must have both new technology and properly trained employees, they take one or more of the following courses of action:

- Hire young adults only if they demonstrate an acceptable degree of literacy.
- Demote or dismiss "functionally illiterate" workers and recruit more literate ones to replace them.
- Hire or retain "functional illiterates," but put them through extensive remedial basic education before training them for new technology.

The first approach severely restricts the supply of job applicants. The second and third are costly and time-consuming.

The pool of young adults available for civilian jobs will shrink sharply between now and 1995, thus aggravating employers' problems. On the other side of the ledger, it must be noted that no more than 5 percent of young adults are truly illiterate in the sense of being unable to decode words on a page. The great majority of people who have been labelled "functionally illiterate" *can* read. Their burden is that they do not comprehend well enough to use what they have read.

The new design interweaves basic skills training with technical training and ensures that trainees are familiar with the content of written material before they read or write about it. This enables "functional illiterates" to understand and successfully operate new technology. Overall training time is reduced, while the trainees' success rate is increased. Since millions of current and future workers will be burdened with educational deficiencies, employers should do what they can do to further this development.

Those employers who provide remedial basic education to employees and job applicants are performing a public service, in addition to meeting their own needs. They have to perform the public service because public institutions have failed. Should they be reimbursed by the public for the costs of remedial education? Although Work in America's study did not address this question, I believe the answer should be yes, for two reasons: (1) to reinforce the continuation of these activities, and (2) to make public institutions more painfully aware that they must do better.

Discussion

Opening the discussion with an anecdote that suggested the gains to management from successful employee training programs, Morton Bahr cited the example of an AT&T plant manager in South Carolina who allowed workers to pursue training on company time. Although the contract did not require that the training be undertaken on company time, the manager argued that he had more than recouped any production losses from this liberal policy through higher productivity and morale.

Paul Osterman raised two questions: (1) How much is U.S. industry currently investing in training; and (2) Is a larger investment necessary, or is training currently maldistributed between managers and production workers? Robert Zager noted that answers to both questions are lacking. The national investment in training is difficult to measure. Should it, for example, include some valuation of the amount of employee time spent in training during the workday? All that can be said with confidence is that the investment amounts to billions of dollars. As for the effectiveness of training, he added, one can look at specific programs, but there is very little evaluation of the overall system.

William Scranton commented that the public sector, especially state government, is very much involved in training and suggested that a more effective national training system will have to involve both the public and private sectors. He indicated, however, that an effective system must provide both a broad range of services and a diverse array of training options. Scranton cited a pilot program conducted at Allegheny Community College in Pittsburgh in which a broad range of training options was combined with intensive counseling to allow displaced workers to make their own decisions about retraining and re-employment:

> **. . . It wasn't a choice that they had to make in a vacuum. It [the program] made**

> **available to them . . . vouchers and . . . counseling as to what they might want to get involved in. . . . Now, the choice wasn't infinite, but it was far broader than the normal program. And then once they made the decision, they had the opportunity to be trained in that area. And meeting them was a remarkable experience because to a man and a woman . . . they all had a sense now of control over their own destiny whereas before they did not.**
>
> **[This program] solves two problems. . . . It eventually trains people in usable job skills, but it also empowers a person with a sense of their co-responsibility for employment rather than making them the objects of an economy . . . just as [do] many of the kinds of programs we are talking about today. . . . The goal there is to empower workers to make decisions on levels that decisions had not been made before.**

Larry McKean noted that another significant problem in worker training stems from the weak preparation of many entrants to the labor force. Firms increasingly have to teach basic skills to new employees before they can train them in job-related skills. McKean reported that the Boeing Company, operating in a regional economy with low unemployment (western Washington state), had been reduced to hiring workers who had high school diplomas but had trouble understanding how to complete their employment applications. According to McKean, one-half of the 18,000 production workers recently hired by his firm required at least a month of remedial training in basic skills.

Morton Bahr said there is a "lost generation" of 16-to-25 year-olds who are unemployable because they lack basic skills. Malcolm Lovell suggested that employer provision of basic remedial education for employed workers and labor force entrants might be funded through a joint program encompassing a Federal contribution of perhaps 20 percent, matching funds by the states of an additional 25 percent, and the balance from private industry.

Alonzo Crim (Professor, Georgia State University, former Superintendent of Schools in Atlanta, Georgia, and a member of the Panel on Technology and Employment) noted that much of the current crisis in primary and secondary education reflects the fact that the demands on public schools in many urban areas have increased dramatically as other social institutions and support systems have eroded. The public schools cannot bear this burden alone and need assistance from the private sector:

> **What has happened to the family, what has happened especially to the extended family and community support systems [is such that] we have to begin to look at new organizations to give support to kids. . . . There has to be that kind of reorganization of both business and other elements of the community to give support to the kids where, number 1, they want to stay in school, and, number 2, that they see some reason at the end of the tunnel for them to do well while they are in school, and I think we see a lot of that beginning to happen.**

William Burrus argued that training and education cannot be addressed in isolation, but are part of a larger set of problems. Better housing and jobs, in his view, are essential preconditions to improvements in the education of the next generation. A child of a family that is on welfare or has no wage earner has neither the role model nor the incentive to pursue education. Pouring money into education alone will miss a large group of individuals in the underclass and will perpetuate it.

Concluding the discussion, John Stepp described the results of a study by a committee of the Organization for Economic Cooperation and Development that examined the training practices of private employers in a number of industrial economies. The study concluded that where employers had maximum discretion to hire and fire employees, they tended to invest less in employee training and upgrading. Stepp suggested that this finding reflected the tendency for the returns on such an investment to be lost if employees move to another firm, creating an "externality"—firms do not reap the full returns on their training investment:

> **Now I agree that our schools have failed us, but I think if we simply point at the schools and say that the problems are the illiterates and the midliterates, we are ignoring a whole class of people who need to be constantly retrofitted and given new skills. And we need to invest far more in them than we have in the past, and we are not willing to do that given the easy way out that we have. . . . Until we can deal with this externalities issue, there is going to be systematic underinvestment by employers [in worker training] in this country, and we are going to suffer in terms of productivity and competitiveness.**

Sheldon Friedman agreed that there is a strong link between employment security and training, arguing that if employers do not have the option of laying off workers, they will have stronger incentives to invest in training for these workers:

> **You can get there through collective bargaining. You can get there through public policy, but some way or another you have got to get to a higher level of employment security. If you do, that will result in a lot more investment in continuous lifelong training by employers.**

Conclusion

John Stepp concluded the day's discussion by expressing his hope that this and other labor-management dialogues would contribute to improvement in the climate of labor-management relations. He expressed a desire to support additional meetings and dialogues:

> **We need to find more venues for labor and management and third parties to come and to discuss and to at times argue over some of these issues. There is too little of that, and we are prepared to try to be a sponsor and convener of future meetings like this.**

Richard Cyert, summarizing his interpretation of the day's discussions, suggested that lying behind much of the discussion is concern about the international competitiveness of this economy. Although technology is an important part of the solution to our national competitiveness problems, the rapid introduction of new technologies can create other problems, such as worker displacement in specific sectors or industries and an increased need for worker training. In some industries, the introduction of new technologies leads to increased employee involvement in decisions that formerly were the exclusive province of management. This shift in decisionmaking authority has in some instances made labor-management cooperation difficult, because it threatens management prerogatives and power, especially the prerogatives and power of middle management. All of these issues must be addressed through a national effort that involves government at all levels, public and private educational institutions, and the private sector, rather than leaving individual managers and workers to fend for themselves:

> **In the case of introduction of new technology, the tendency is to shift the [responsibility for adjustment] to individuals. It is the individuals who have to give up their jobs and find some other way of operating. . . .**

Notwithstanding such challenges, Cyert concluded, the important point is that with the introduction of competitive technology many more jobs can be gained than lost. Cooperation in new technology adoption can expand the total pie and create significant gains for both labor and management.

Appendix A: Meeting Participants

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Appendix B: The Panel on Technology and Employment

The Panel on Technology and Employment was organized by the Committee on Science, Engineering, and Public Policy, a joint committee of the National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, in 1985 to analyze the effects of new technologies on employment, working conditions, wages, and workplace health and safety, among other issues. Members of the Panel were as follows, with their affiliations at the time of their service on the Panel:

Richard M. Cyert (Chairman), President, Carnegie-Mellon University

Morton Bahr, President, Communications Workers of America

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William W. Scranton, Lieutenant Governor, Commonwealth of Pennsylvania, 1979–1987

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The Panel on Technology and Employment was supported from public and private sources. Within the federal government, support was provided by the U.S. Department of Labor (the Assistant Secretary for Policy), the U.S. Department of Commerce (the Economic Development Administration), and the U.S. Army Recruiting Command. The following private organizations supported the study and activities of the Panel: the AT&T Foundation, the Amer-

ican Federation of Labor and Congress of Industrial Organizations, Citicorp, the Computer and Business Equipment Manufacturers Association, the General Motors Foundation, IBM Corporation, and the Xerox Foundation.

The project also received support from the Thomas L. Casey Fund of the National Academy of Sciences and the National Research Council (NRC) Fund. The NRC Fund, a pool of private, discretionary, nonfederal funds, consists of contributions from a consortium of private foundations including the Carnegie Corporation of New York, the Charles E. Culpeper Foundation, the William and Flora Hewlett Foundation, the John D. and Catherine T. MacArthur Foundation, the Andrew W. Mellon Foundation, the Rockefeller Foundation, and the Alfred P. Sloan Foundation. Additional funds were provided by the Academy Industry Program, supported by contributions from companies that are concerned with the health of U.S. science and technology and with public policy issues that have technology content, and the National Academy of Sciences and the National Academy of Engineering endowments.

☆U.S. Government Printing Office : 1988 - 202-285/00725